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NATIONAL DAM SAFETY PROGRAM. HAMILTON CITY WATER PLANT DAM (MO --ETC(U)
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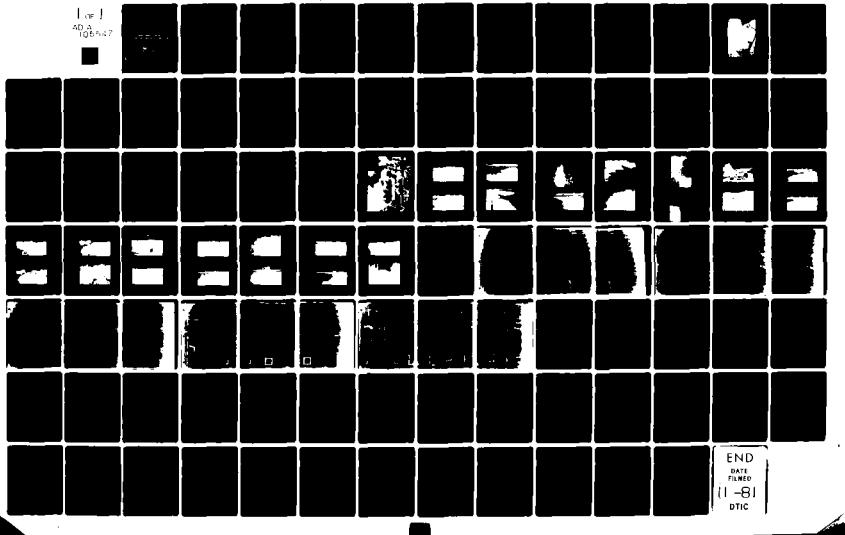

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HAMILTON CITY WATER PLANT DAM

CALDWELL COUNTY, MISSOURI

MO. 10261

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JULY, 1980

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Caldwell County, Missouri

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*
This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

HAMILTON CITY WATER PLANT DAM
CALDWELL COUNTY, MISSOURI
MISSOURI INVENTORY NO. MO 10261

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JULY, 1980

A

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Hamilton City Water Plant Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Hamilton City Water Plant Dam (MO 10261).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway(s) will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division — 5 JAN 1981 — Date

APPROVED BY:
Colonel, CE, District Engineer — 5 JAN 1981 — Date
SIGNED

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Hamilton City Water Plant Dam
State Located	Missouri
County Located	Caldwell County
Stream	Tom Creek
Date of Inspection	July 1, 1980

Hamilton City Water Plant Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Hamilton City Water Plant Dam has a height of thirty-six (36) feet and a storage capacity at the minimum top elevation of the dam of twelve hundred (1200) acre-feet. In accordance with the guidelines, an intermediate size dam has a height greater than or equal to forty (40) feet but less than one hundred (100) feet and a storage capacity greater than or equal to one thousand (1,000) acre-feet but less than fifty thousand (50,000) acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category. Hamilton City Water Plant Dam is classified as an intermediate size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high potential for damage and loss of life. Failure would threaten life and property. The estimated damage zone extends approximately seven (7) miles downstream of the dam. Within the damage zone are the City of Hamilton water treatment plant and Highway 36 Business Route (immediately downstream), Highway 36 (0.3 miles downstream), two dwellings and two barns (2.3 miles downstream), one dwelling and two barns (2.8 miles downstream) and Highway 13 (3.3 miles downstream).

Our inspection and evaluation indicate that the spillways do not meet the minimum criteria set forth in the recommended guidelines for an intermediate dam having a high hazard potential. The Probable Maximum Flood is the appropriate spillway flood. The spillways will pass the 100-year flood (a flood having a 1 percent probability of being exceeded in any year) without overtopping the dam. The spillways will pass 30 percent of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected

from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Construction plans were available for this dam. Based on the information available from the plans and the observations made during the field inspection, the following deficiencies were found: inadequate spillway capacity, lack of seepage and stability analyses, tree growth on embankment and in outlet channel of the concrete spillway, erosion of areas of the upstream slope, displacement of the downstream sections of the concrete stilling basin, and open joints and scaling concrete in the concrete spillway. Remedial measures and maintenance procedures are recommended as listed below. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

a. Alternatives
   (1) The spillway size and/or the height of dam should be increased to pass the Probable Maximum Flood without overtopping the dam.

b. Operation and Maintenance Procedures
   (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by a professional engineer experienced in the design and construction of dams.
   (2) Trees should be removed from the embankment slopes and the outlet channel of the concrete spillway. This should be done under the guidance of a professional engineer experienced in the design and construction of dams.
   (3) The eroded areas of the upstream slope should be repaired and additional riprap provided in order to prevent further erosion and deterioration of the slope. This should be done under the guidance of a professional engineer experienced in the design and construction of dams.
   (4) The last downstream sections of the concrete stilling basin should be monitored periodically to determine whether the inward displacement at the top of the walls is increasing. Remedial measures may be required.
   (5) The joints on the concrete spillway structure should be checked for missing joint filler. Open joints should be resealed.
   (6) The areas of the floor section and the walls of the concrete spillway structure where scaling has occurred should be repaired.

(7) The present practice of mowing the embankment is excellent and should be continued.

(8) A program of periodic inspection and maintenance should be initiated. Records of inspections should be made a part of the project file.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-19246

H. P. Hoskins

Harold P. Hoskins, Chairman of the Board
Hoskins-Western-Sonderegger, Inc.
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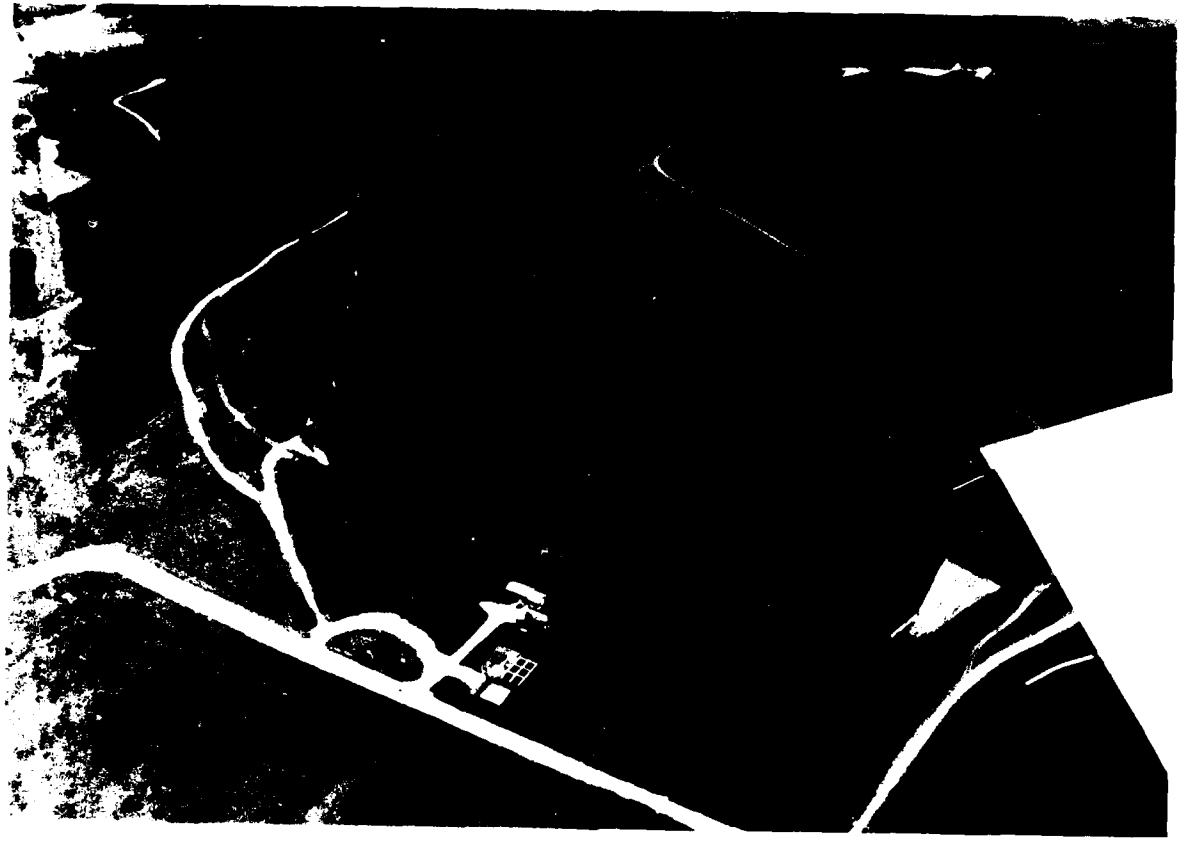


PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
HAMILTON CITY WATER PLANT DAM - MO 10261
CALDWELL COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army through the Corps of Engineers to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District Corps of Engineers District Engineer directed that a safety inspection of Hamilton City Water Plant Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams," dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth fill of intermediate size located in the dissected till plains area within the Central Lowlands Physiographic Region about a mile west of Hamilton, Missouri. The dam is approximately 1300 feet in length with a maximum height of about 36 feet. The maximum water storage at the minimum top elevation of the dam is 1200 acre-feet.

The dam consists of two legs with the principal embankment oriented almost east-west and the secondary wing dike oriented northeast-southwest. The principal or primary spillway is located at the left end of the secondary wing dike. There is an emergency or secondary spillway cut through the right abutment of the principal (east-west) embankment.

(2) The principal spillway is uncontrolled and consists of a vegetated earth approach channel excavated in the left abutment leading to a St. Anthony Falls type reinforced concrete chute.

(3) An uncontrolled, vegetated earth emergency spillway is cut through the right abutment. A 4-foot high dike used for a road crossing is constructed normal to the spillway along the centerline of the dam.

(4) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the north central portion of Caldwell County, Missouri, about 1 mile west of the City of Hamilton as shown on Plate A-2. The dam is shown on Plate A-1 in the SW1/4 of Section 15, T57N, R28W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Hamilton City Water Plant Dam has a height of 36 feet and a storage capacity of 1,200 acre-feet. This dam is classified as an intermediate size dam. An intermediate size dam has a height greater than or equal to 40 feet but less than 100 feet and a storage capacity greater than or equal to 1,000 acre-feet but less than 50,000 acre-feet. The size classification is determined by either the storage or height, whichever gives the larger size capacity.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines this dam is in the High Hazard Potential Classification. The estimated damage zone extends approximately seven miles downstream of the dam. It was determined by visual observation that within the damage zone are the City of Hamilton water treatment plant and Highway 36 Business Route (immediately downstream), Highway 36 (0.3 miles downstream), two dwellings and two barns (2.3 miles downstream), one dwelling and two barns (2.8 miles downstream), and Highway 13 (3.3 miles downstream).

e. Ownership. The dam is owned by the City of Hamilton, City Hall, Hamilton, Missouri 64644.

f. Purpose of Dam. The dam was constructed primarily as a source of water supply for the City of Hamilton, Missouri. It also provides recreation for the residents of the surrounding area.

g. Design and Construction History. Mr. Kuhnert, Water Superintendent for the City of Hamilton, stated that the initial dam construction at this site was done in 1920. The original dam was constructed with a 6-inch concrete core wall. In 1954 the dam as it presently exists was constructed from plans prepared by Kenneth H. Larkin

and Associates, Consulting Engineers, Kansas City, Missouri. The concrete core wall was left in place; the height of the dam was raised 12 feet ±; the left wing of the dam was constructed; the dam was extended approximately 365 feet on the right and the two spillways were constructed.

h. Normal Operating Procedure. The intake tower for the city water supply is equipped with two 8-inch cast iron intake pipes which are controlled by hand-operated rising stem gate valves. Water is drawn from the intake tower into the filtration plant through one 8-inch cast iron pipe as required to meet the City's demand for water. The pool level behind the dam is controlled by rainfall, infiltration, evaporation, the capacity of the uncontrolled spillways and the demand for potable water by the City of Hamilton.

1.3 PERTINENT DATA

a. Drainage Area. 1,141 acres (1.783 square miles).

b. Discharge at Damsite.

(1) Discharges at the damsite are through the following:

(a) An uncontrolled principal spillway consisting of a vegetated earth approach channel excavated in the left abutment leading to a St. Anthony Falls type reinforced concrete chute having a crest width of 110 feet.

(b) An uncontrolled vegetated earth emergency spillway, 85 feet in width, excavated in the right abutment. A 4-foot high dike crosses the spillway normal to the centerline of the spillway.

(c) An intake tower equipped with two 8-inch cast iron intake pipes which are manually controlled by rising stem gate valves. Water is drawn from the intake tower through an 8-inch cast iron pipe into the Hamilton water treatment plant located at the downstream toe of the dam.

(2) Estimated Maximum Flood at Damsite. The City Water Superintendent, Mr. Kuhnert, stated that 18 to 24 inches of water flowed through the control section of the principal spillway in 1964 or 1965.

(3) The principal spillway capacity varies from o c.f.s. at elevation 110.0 feet to 2050 c.f.s. at the crest of the emergency spillway (elevation 113.5 feet) to 2250 c.f.s. at the minimum top of dam (elevation 113.7 feet).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation 113.5 feet to 7 c.f.s. at elevation 113.7 feet (minimum top of dam).

(5) Total spillway capacity at the minimum top of dam is 2257 c.f.s. ±

c. Elevations. (Local datum to conform with construction plans)

(1) Observed pool - 108.7
(2) Normal pool - 110.0
(3) Spillway crest(s)
Principal - 110.0
Emergency - 113.5
(4) Maximum experienced pool - 112 ±
(5) Top of dam (minimum) - 113.7
(6) Streambed at centerline - 78 ±
(7) Maximum tailwater - unknown

d. Reservoir - Length (feet) of Pool.

(1) At principal spillway crest - 4,000 ±
(2) At emergency spillway crest - 4,300 ±
(3) At top of dam (minimum) - 4,300 ±

e. Storage (Acre-feet).

(1) Observed pool - 800 ±
(2) Normal pool - 900 ±
(3) Spillway crest(s)
Principal - 900 ±
Emergency - 1200 ±
(4) Maximum experienced pool - 1050 ±
(5) Top of dam (minimum) - 1200 ±

f. Reservoir Surface (Acres).

(1) Observed pool - 67 ±
(2) Normal pool - 73 ±
(3) Spillway crest(s)
Principal - 73 ±
Emergency - 90 ±
(4) Maximum experienced pool - 82 ±
(5) Top of dam (minimum) - 91 ±

g. Dam.

(1) Type - Homogeneous rolled earth fill

(2) Length - 1300 feet ±

(3) Height - 36 feet ± (maximum)

(4) Top width - 10 feet ± (plans); 13 feet (measured)

(5) Side slopes -
(a) Downstream - 1V on 3H (Plans and measured). 1V on 2.25H (Plans and measured above filter building)
(b) Upstream - 1V on 2H (Plans) 1V on 2.75H (measured on exposed face)

(6) Zoning - none

(7) Impervious core - 6" concrete core wall - Sta. 6 + 65 to Sta. 12 + 50.4 in old dam which forms an upstream berm for the existing dam.

(8) Cutoff - unknown

(9) Grout curtain - none

(10) Wave protection - Riprap (8-10 inch maximum size)

(11) Drains - Pervious blanket (Sta. 8 + 50 to Sta. 11 + 50) with 6-inch perforated corrugated metal pipe connecting to manhole at water treatment plant. The location of the pervious blanket is shown on Plate C-2.

h. Diversion Channel and Regulating Tunnel - none

i. Spillway.

(1) Principal

(a) Type - An uncontrolled vegetated earth approach channel excavated in the left abutment leading to a St. Anthony Falls type reinforced concrete chute having a crest width of 110 feet and a total length from crest to end sill of 180 feet.

(b) Crest Elevation - 110.0
End Sill Elevation - 79.0

(c) Upstream Channel - Free of obstructions and well vegetated.

(d) Downstream Channel - Well vegetated, few trees, highway bridge about 450 feet downstream from spillway chute.

(2) Emergency

(a) Type - Uncontrolled vegetated earth spillway having a width of 85 feet and side slopes of 1V on 4H.

(b) Control Section - A 4-foot high dike crossing the spillway normal to the spillway centerline.

(c) Crest Elevation - 113.5

(d) Upstream Channel - Well vegetated, open

(e) Downstream Channel - Well vegetated, open

j. Regulating Outlets - Water is supplied to the city water intake tower by either of two 8-inch cast iron pipe intake lines that extend from the intake tower into the reservoir. These lines are manualled controlled by operation of rising stem gate valves mounted within the intake tower on the ends of the intake pipes. Water is drawn from the intake tower into the filtration plant through an 8-inch cast iron pipe which is gate valve controlled within the filtration plant. The lower intake line from the reservoir has one cut-off collar. The 8-inch outlet pipe from the intake tower to the filtration plant is equipped with two cut-off collars. Details are shown on Plate C-4.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for the original dam which was constructed in the 1920's. The plans prepared in 1953 by Kenneth H. Larkin and Associates, Consulting Engineers, Kansas City, Missouri for the enlargement of the dam show the original dam and its spillway as they were prior to the construction in 1954. The plans for the 1954 construction are included in Appendix C.

2.2 CONSTRUCTION

The surveys and measurements made during the inspection indicate that the dam and its spillways were constructed in 1954 in accordance with the plans included in Appendix C. The 6-inch concrete core wall, which was a feature of the original dam, was left in place and the new embankment was constructed on the downstream side of the core wall. The spillway of the original dam was removed, and the dam was extended by construction of the left wing. The dam was also extended approximately 365 feet on the right side. An earth spillway was constructed through the right abutment, and an earth channel leading to a St. Anthony Falls type reinforced concrete spillway chute was constructed through the left abutment.

2.3 OPERATION

No data were available on spillway operation. It was reported by Mr. Kuhnert that the maximum flow through the spillway was about 18 to 24 inches deep which occurred sometime in 1964 or 1965. There has been no significant flow through the spillway since 1974. There was no evidence that would indicate that the dam has been overtopped.

2.4 EVALUATION

a. Availability. The data included in Appendix C were readily available from the City of Hamilton.

b. Adequacy. The available data, field surveys and visual observation presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The available data and information supplied by Mr. Kuhnert are considered valid and acceptable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Hamilton City Water Plant Dam was made on July 1, 1980. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were: Rey S. Decker, Geotechnical; Gordon Jamison and Garold Ulmer, Hydrology and Hydraulics. Mr. B. Kuhnert, Water Superintendent, accompanied the inspection team for part of the time.

b. Dam.

(1) Geology and Soils (abutment and embankment). The Hamilton City Water Plant Dam is located in the dissected till plains area within the Central Lowlands Physiographic Region. The dam is in a region where the stratigraphic sequence consists of 8 to 16 feet of loess overlying Kansan-age glacial till, of undeterminable thickness and character, which in turn overlies bedrock of the Kansas City Group, Missourian Series, Pennsylvanian System. Strata of this group consists of interlayered shales, limestones, sandstones, and thin beds of coal.

The upland soil deposits in the dam area consist of the Adair-Lagonda-Shelby soil association. These soils are formed from loess which overlies glacial till and formed on a rolling to gently rolling topography. The Adair soil has formed in the uppermost and weathered portion of the glacial till. The Lagonda soil has formed from loess occupying positions on gently rolling uplands and interstream divides. The Shelby soil occupies the steeper slopes and has developed from relatively unweathered glacial till.

Materials observed in the abutments consist of CL loess-till colluvium. No till nor bedrock was observed at the site. Materials in the embankment consist of silty clay (CL) soils apparently taken from the spillway excavations and from the upstream abutment areas.

(2) Upstream Slope. The upstream slope is fairly well plated with limestone riprap. The riprap is quite small with nominal size of 1 to 1.5 inches and maximum size of 8 to 10 inches. Some deterioration of the riprap was noted. Some erosion of the slope, 2 to 3 feet above the lake level, was noted along most of the main (E-W) dam. In some areas a near

vertical scarp has developed. In the area between about station 9+00 to 11+00 (stationing according to plans), concrete rubble has been added to the original riprap. A few small trees are growing on the upstream slope. No slumps, slides or abnormal deformations were noted on the slope. Photos No. 14, 16, 19, 24 and 27 show the upstream slope.

(3) Crest. The crest is well vegetated with adapted grasses and legumes. No cracks were observed on the crest. The survey of the crest of the dam indicates that the embankment has settled more than anticipated through the area of the old channel. A note on Plate C-3 of the construction plans specifies overfill between stations 3+00 and 16+00 to allow for settlement. The sag in the crest begins at station 7+00 and ends at station 13+00. The lowest point in the crest occurs at station 9+40+ opposite the intake tower where the crest elevation is 713.7. This elevation is 1.3 feet below the anticipated settled top elevation of the crest and is only two-tenths (0.2') of a foot higher than the crest of the control section of the emergency spillway. Plate C-6 shows the profile of the dam as determined during the inspection. Photos 15, 17 and 23 show the crest of the dam.

(4) Downstream Slope. The downstream slope is well vegetated with adapted grasses. No slumps, slides, cracks or abnormal deformations were observed on the slope. A few small trees are growing on the slope. No evidence of seepage was observed on the slope or along the toe of the slope. Measurements indicate that the slope was constructed according to the plans. Photos No. 15, 18, and 22 show the downstream slope.

c. Appurtenant Structures.

(1) The principal spillway is uncontrolled and consists of a reinforced concrete box, chute and St. Anthony Falls type stilling basin located in the left abutment. Measurements indicate that it was constructed according to the plans shown in Appendix C. The forebay or inlet is well vegetated and open. Photos 3, 4, 5 and 7 show the forebay and overall spillway. The joint between the first and second sections (upstream) of the left sidewall is open about 0.75 inches from the top down about 3 feet as shown in Photo No. 6. The floor of the next to the last (downstream) section of the chute (Sec. D-6 on plans) is badly scaled across most of the bottom, as shown in Photos 9, 12 and 13. All of the lower set of weep holes in the floor section were discharging clear water. The last downstream sections of the side walls of the stilling basin (Sec. H-6 on plans)

are both out of vertical alignment. The top of the left wall is displaced inward about 3 inches. The top of the right wall is displaced inward about 1.5 inches. The misalignments of the sidewalls are shown in Photos 10 and 11.

(2) The emergency spillway is uncontrolled and consists of a vegetated earth channel cut through the right abutment with a roadway crossing that serves as a control weir. The spillway is well vegetated with adapted grasses. Measurements indicate that the spillway was constructed essentially as planned. No slides or slumps were observed, and there was no evidence of significant erosion in the spillway. There was no evidence that this spillway has operated. As noted previously, if this emergency spillway operates, there will probably be flow over the low swag in the crest of the dam. Photos 25 and 26 show the emergency spillway.

(3) The drawdown facility for this dam is related entirely to providing water for the city water treatment plant through the intake tower. Two 8-inch cast iron pipe intake lines extend from the intake tower into the reservoir. These lines are shown on the plans at elevations of 105 and 95 and are manually controlled by operation of rising stem gate valves. The elevation of the lower line is estimated to be 15 feet ± above the low point in the reservoir. Water is drawn from the intake tower into the filtration plant through an 8-inch cast iron pipe which is gate valve controlled within the plant. The volume of flow through this line is dependent upon the demand for potable water by the city.

d. Reservoir Area. The area around the reservoir is well vegetated with grass. No slides were observed and there was no evidence of significant erosion around the water line of the reservoir. There was no evidence of heavy siltation. Photo No. 20 shows a portion of the reservoir.

e. Downstream Channel. The channel downstream from the principal spillway appears to be stable. Mr. Kuhnert reported that bedrock is close to the surface in the outlet channel. A number of trees are growing in the channel between the highway bridge and the structure. Photos No. 5 and 28 show the principal spillway channel.

The channel for the emergency spillway is open and vegetated with grass. Discharge from the emergency spillway would probably encroach upon the toe of the dam and the filtration plant.

3.2 EVALUATION

The dam appears to be in reasonably good structural condition with no serious potential of failure. There were no indications of

seepage on the downstream slope or along the toe of the dam. The crest of the embankment is very irregular with one area about the same elevation as the emergency spillway. The crest elevation should be brought up to planned elevation. Deterioration of the riprap and erosion on the upstream slope could ultimately impair the integrity of the dam. Trees on the embankment should be removed under the guidance of a professional engineer experienced in the design and construction of dams. The open joints in the walls and the scaling in the floor or the principal spillway should be repaired to prevent further deterioration. Removal of trees in the principal spillway channel would improve the discharge characteristics of the structure. The dike that crosses the emergency spillway reduces the capacity of the spillway and consideration should be given to its removal.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool level is controlled by rainfall, infiltration, evaporation, the capacity of the uncontrolled spillways, and the demand for city water.

4.2 MAINTENANCE OF DAM

Maintenance of the vegetated sections of the dam appears to be good. One of Mr. Kuhnert's men reported that the crest and slopes of the dam are mowed several times each year. Some effort has been made to supplement the riprap on the upstream slope, but additional repair and maintenance is needed. No apparent maintenance work has been done on the concrete spillway.

4.3 MAINTENANCE OF OPERATING FACILITIES

The operating facilities connected with the withdrawal of water from the reservoir and treating it for use by the city appeared to be well maintained.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

Maintenance and repair should be done on the concrete spillway in order to prevent further deterioration. The same applies to the upstream slope of the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Plans for the 1954 reconstruction of the dam were furnished by the Hamilton City Water Department.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Polo and Winston, Missouri, 15 minute topographic quadrangle maps. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection. Hydraulic/Hydrologic computations are attached as Appendix D of this report.

c. Visual Observations.

(1) The concrete principal spillway is only in fair condition. As the photographs indicate, much of the joint filler in the side walls has slipped or fallen out entirely, some of the side wall sections are considerably out of line, and there are several areas on the floor that show spalling and scaling.

(2) The earthen spillway channel through the right abutment is open and well vegetated on both upstream and downstream sides of the roadway dike that now serves as the control section of the spillway. The construction plans (Plate C-2) show that the spillway channel was to be excavated to an elevation of 110.2. The dike was then to be constructed across the excavated channel with a finished top elevation of 113.5 (confirmed during inspection). The dike was evidently constructed in order to provide a vehicular crossing of the spillway and with the knowledge that if overtopped the dike would erode down to the channel elevation of 110.2 which would then be the control elevation of the spillway. The control elevation of this spillway was intended to be two-tenths of a foot higher than the control section of the concrete spillway constructed through the right abutment (110.2 as compared to 110.0). The elevation difference between the crest of the emergency spillway and the low point in the crest of the dam is only two-tenths of a foot as described in paragraph 3.1b.(3) of this report. Overtopping of the dam immediately above the filter house would occur very shortly after flow commenced through the emergency spillway.

(3) More riprap should be added to several areas on the upstream face of the dam.

d. Overtopping Potential. The spillways are too small to pass the probable maximum flood without overtopping the dam. The spillways will pass 30 percent of the probable maximum flood as well as the 1 percent probability flood without overtopping. Overtopping is dangerous because the flow of water over the crest will erode the face of the dam and, if continued long enough, will breach the dam with sudden release of all of the impounded water into the downstream floodplain. The hydrologic capability of this dam would be greatly enhanced by removal of the dike crossing the emergency spillway and by increasing the height of the low areas of the dam to the planned elevation of 115.0.

The results of the routing through the dam are tabulated in regards to the following conditions:

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	Maximum Depth Over Dam Feet*	Duration Over Top Hours
1/2 PMF	5,660	4,080	114.7	1.0	2
PMF	11,300	10,500	115.9	2.2	5
0.3 PMF	3,750	2,260	113.7	0.0	-

*Minimum Top of Dam Elevation - 113.7

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard potential rating and an intermediate size. Therefore, the PMF is the test for the adequacy of the dam and its spillways.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. There was no visual evidence such as slumps, slides, cracks or abnormal deformations to indicate structural instability of this dam. No evidence of seepage was observed either on the downstream slope or along the toe of the dam. Based on visual inspection and measurements the dam is considered to be structurally stable against shear and seepage failures. The area of the dam in which the sag in the crest exists (station 7+00 to 13+00) shows no evidence of abnormal deformation in the downstream slope. A cross section survey made during the inspection shows a slope of 1V on 2.3±H as compared to 1V on 2.25H as shown on the construction plans for the area upstream from the filter house (Plates C-7 and C-2). The embankment through the sag area has evidently settled more than originally anticipated. Reconstruction of the crest of the dam through the sag area to a uniform elevation of 115.0 (as planned) would minimize the danger of overtopping. The erosion of the upstream slope and tree growth on the embankment, if allowed to progress, could ultimately impair the integrity of the dam. The effects of overtopping on the erosional stability of the dam are not known. Continued deterioration of the concrete floor and the wall joints of the principal spillway should be halted.

b. Design and Construction Data. Design data were available from the City of Hamilton. Measurements indicate that the structure was constructed according to the Kenneth H. Larkin and Associates plans, which are included in Appendix C. Seepage and slope stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available. This is considered a deficiency.

c. Operating Records. The operating facilities of this dam are used as needed to fulfill the demand for city water.

d. Post Construction Changes. The inspection team is not aware of any post construction changes for this dam since the 1954 construction.

3. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam or the concrete spillway.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. This dam is in reasonably good structural condition. Analyses presented in Section 5 indicate that the spillways are not adequate to pass the Probable Maximum Flood without overtopping the dam. Overtopping is dangerous because the flow of water over the crest will erode the face of the dam and, if continued long enough, will breach the dam with sudden release of all of the impounded water into the downstream floodplain. Overtopping of this dam will occur almost directly above the city water treatment plant.

Based on visual inspection and measurements this dam is considered to be structurally stable against shear and seepage failures. Erosion on the upstream slope and tree growth on the embankment could impair the integrity of the structure if left uncontrolled. Deterioration of portions of the concrete spillway could ultimately require major repairs of the structure if remedial measures are not performed. Removal of trees in the principal spillway channel would improve the hydraulic efficiency of the structure. The hydrologic capabilities of the dam would be greatly enhanced by removal of the dike in the emergency spillway and by increasing the height of the low sections of the dam to be planned elevation of 115.0

b. Adequacy of Information. The conclusions in this report are based upon performance history, visual observations, and data made available by the city. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The measures recommended in paragraph 7.2b should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Further Investigations. The additional studies and analyses recommended in paragraph 7.2b should be accomplished by the owner in the near future.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam. It is recommended, however, that the prescribed seismic loading for Seismic Zone 1 be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a registered professional engineer experienced in the design and construction of earth dams.

a. Alternatives. The spillway size and/or the height of dam should be increased to pass the probable maximum flood without overtopping the dam.

b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by a professional engineer experienced in the design and construction of dams.

(2) Trees should be removed from the embankment slopes and the outlet channel of the concrete spillway. This should be done under the guidance of a professional engineer experienced in the design and construction of dams.

(3) The eroded areas of the upstream slope should be repaired and additional riprap provided in order to prevent further erosion and deterioration of the slope. This should be done under the guidance of a professional engineer experienced in the design and construction of dams.

(4) The last downstream sections of the concrete stilling basin should be monitored periodically to determine whether the inward displacement at the top of the walls is increasing. Remedial measures may be required.

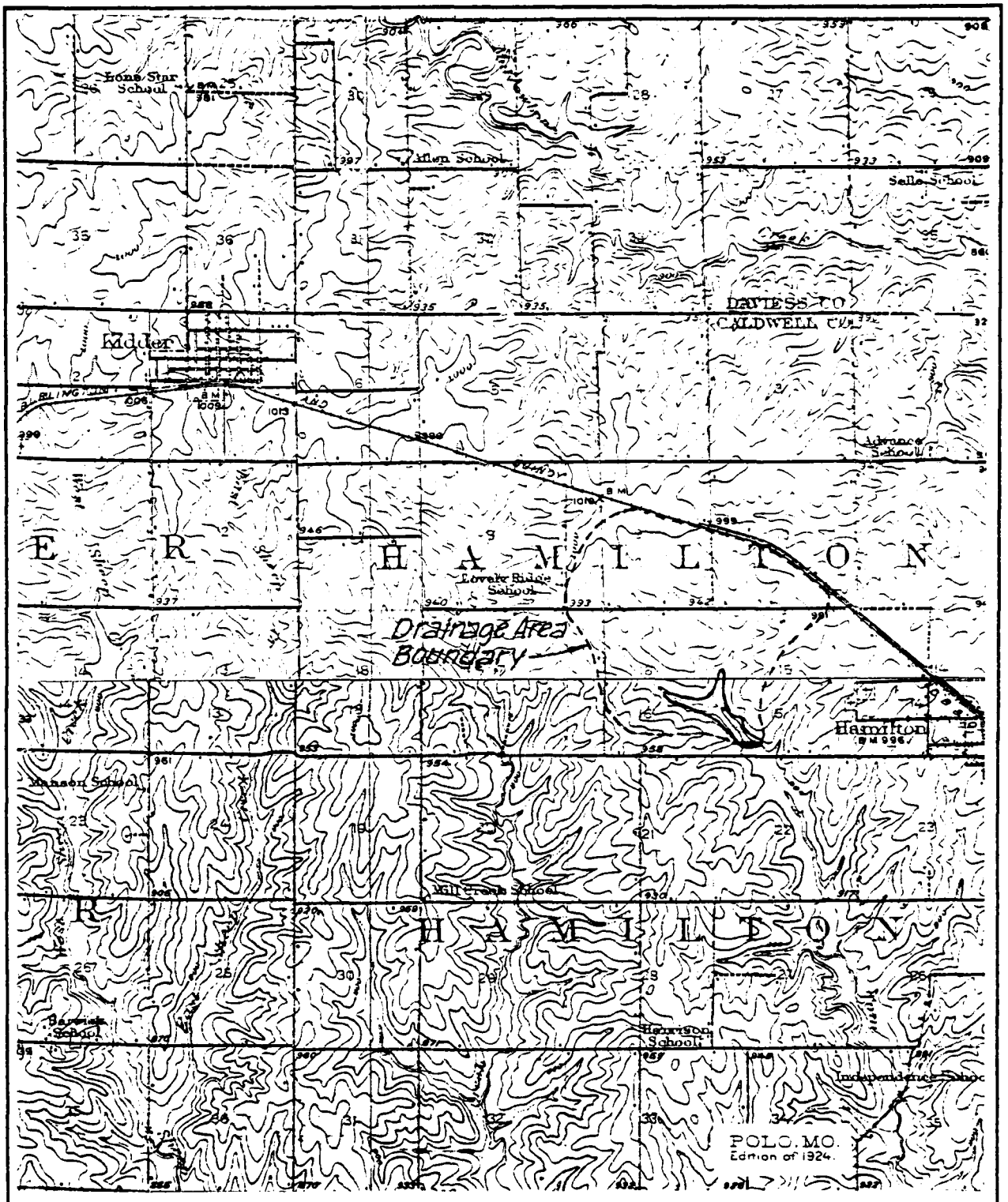
(5) The joints in the concrete spillway structure should be checked for missing joint filler. Open joints should be resealed.

(6) The areas of the floor section and the walls of the concrete spillway structure where scaling has occurred should be repaired.

(7) The present practice of mowing the embankment is excellent and should be continued.

(8) A program of periodic inspection and maintenance should be initiated. Records of inspection should be made a part of the project file.

APPENDIX A
MAPS



Scale in feet

3000 0 3000 6000 9000 12000

Contour Interval – 20'

N

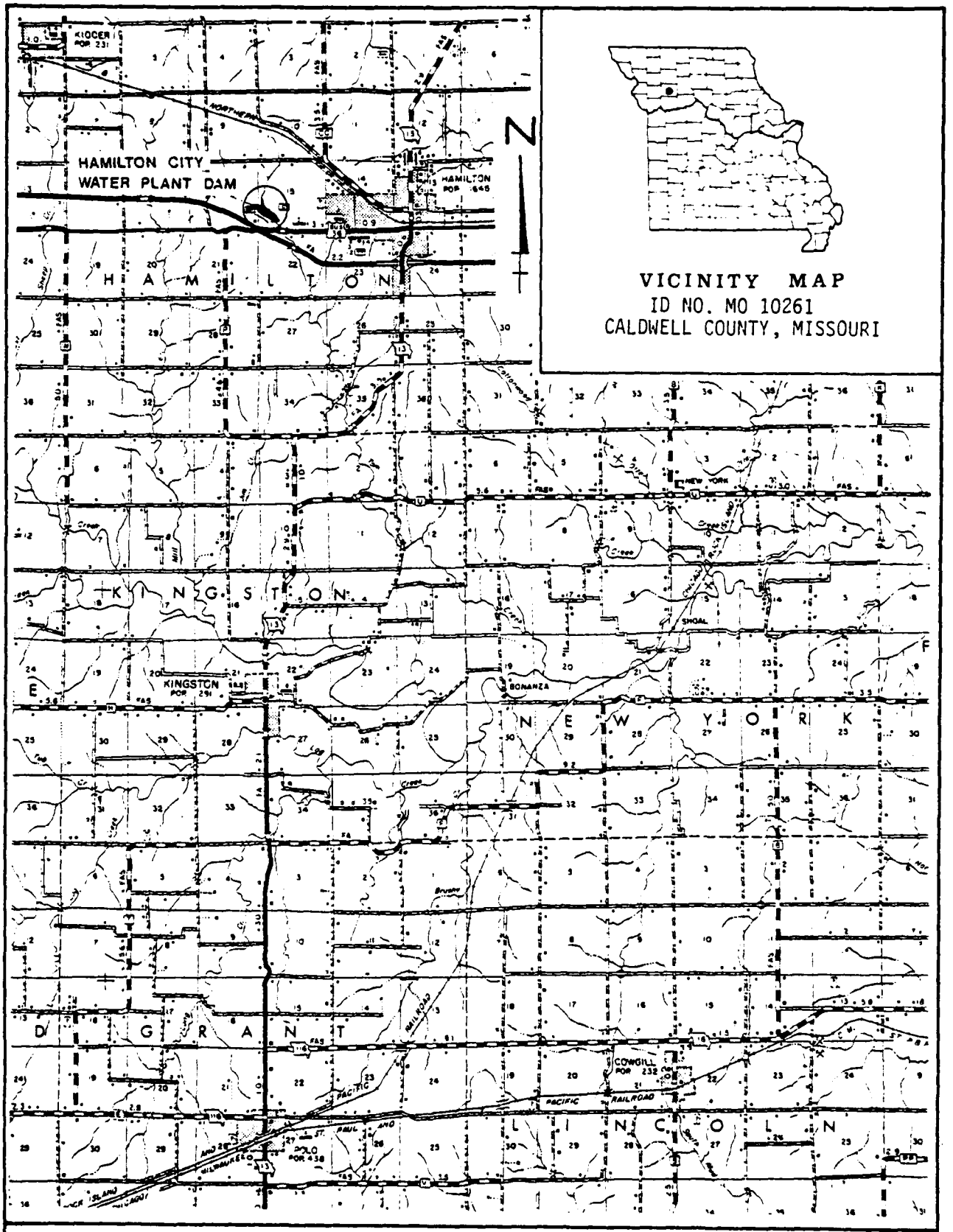
VICINITY TOPOGRAPHY

HAMILTON CITY WATER PLANT DAM

CALDWELL COUNTY, MISSOURI

MO. 10261

PLATE A-1


HAMILTON CITY
WATER PLANT DAM
HAMILTON
KINGSTON
BONANZA
COWGILL
POLO
NEW YORK
SHOAL
HAMILTON
KINGSTON
DAVIESS
NEW YORK
LINCOLN
N
VICINITY MAP
ID NO. MO 10261
CALDWELL COUNTY, MISSOURI
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2

APPENDIX B
PHOTOGRAPHS

HAMILTON CITY WATER PLANT DAM
CALDWELL COUNTY, MISSOURI
MO 10261

PHOTO INDEX

PLATE B-1

PHOTO NO. 2 - OVERVIEW TAKEN FROM UPPER LEFT SIDE.

PHOTO NO. 3 - ENTRANCE CHANNEL TO PRINCIPAL SPILLWAY. LOOKING DOWNSTREAM TO CONCRETE CHUTE.

PHOTO NO. 4 - VIEW OF PRINCIPAL SPILLWAY CHUTE TAKEN FROM LEFT SIDE.

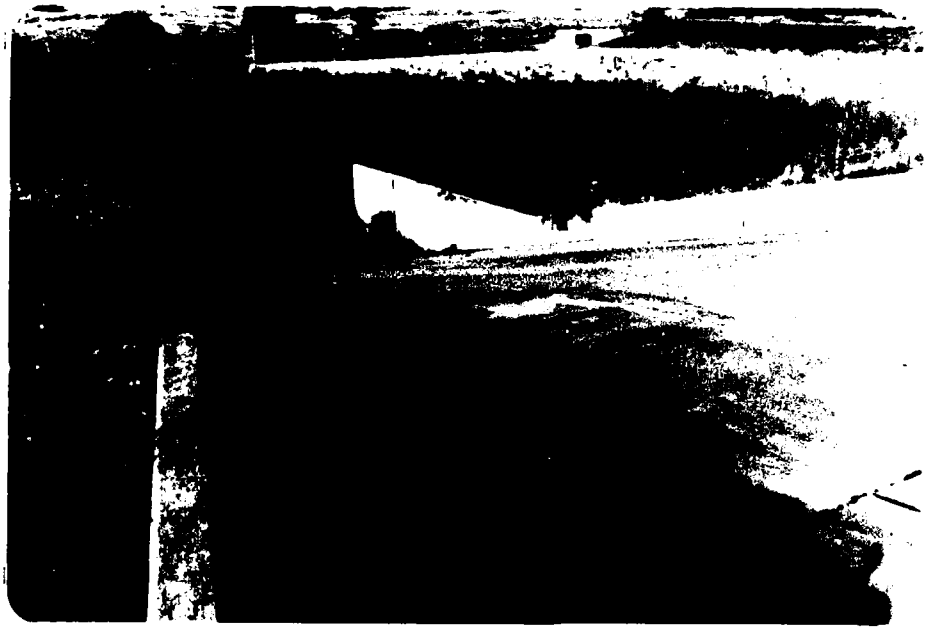


PHOTO NO. 5 - LOOKING DOWN PRINCIPAL SPILLWAY CHUTE FROM LEFT SIDE.

PHOTO NO. 6 - VIEW OF OPENING OF FIRST JOINT ON LEFT SIDE OF PRINCIPAL SPILLWAY CHUTE.

PHOTO NO. 7 - VIEW OF FOREBAY OF PRINCIPAL SPILLWAY CHUTE TAKEN FROM LEFT SIDE.

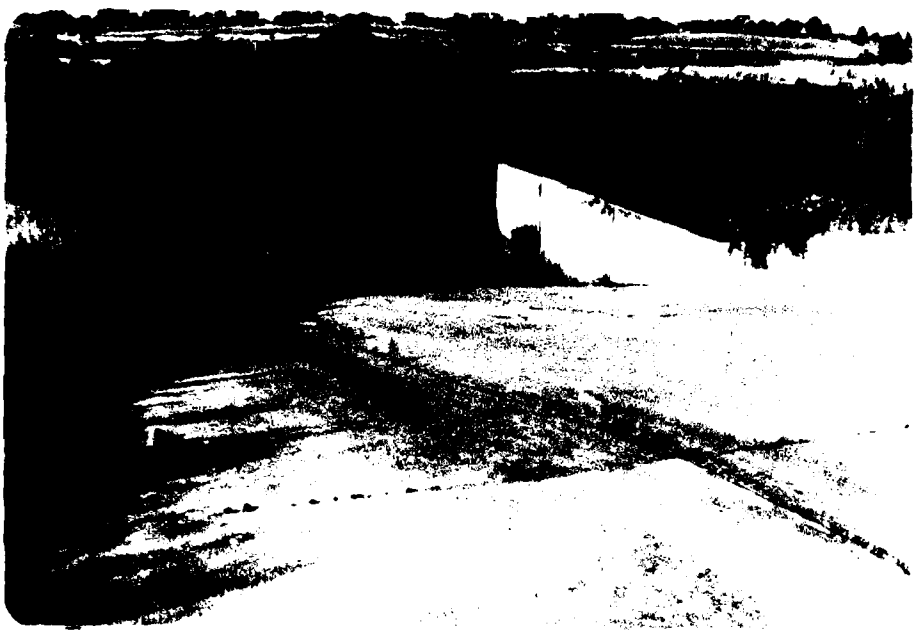


PHOTO NO. 8 - DOWNSTREAM VIEW OF PRINCIPAL SPILLWAY CHUTE.

PHOTO NO. 9 - CONCRETE SCALING AT SECOND JOINT ON LEFT SIDE OF PRINCIPAL SPILLWAY CHUTE.

PHOTO NO. 10 - MISALIGNMENT OF DOWNSTREAM SECTION OF SPILLWAY ON LEFT SIDE.

PHOTO NO. 11 - MISALIGNMENT OF DOWNSTREAM SECTION OF SPILLWAY ON RIGHT SIDE.

PHOTO NO. 12 - CONCRETE SCALING UPSTREAM OF CHUTE BLOCKS ON LEFT SIDE OF CENTERLINE.

PHOTO NO. 13 - CONCRETE SCALING UPSTREAM OF CHUTE BLOCKS ON RIGHT SIDE OF CENTERLINE.

PHOTO NO. 14 - UPSTREAM FACE TAKEN FROM END OF LEFT LEG OF DAM.

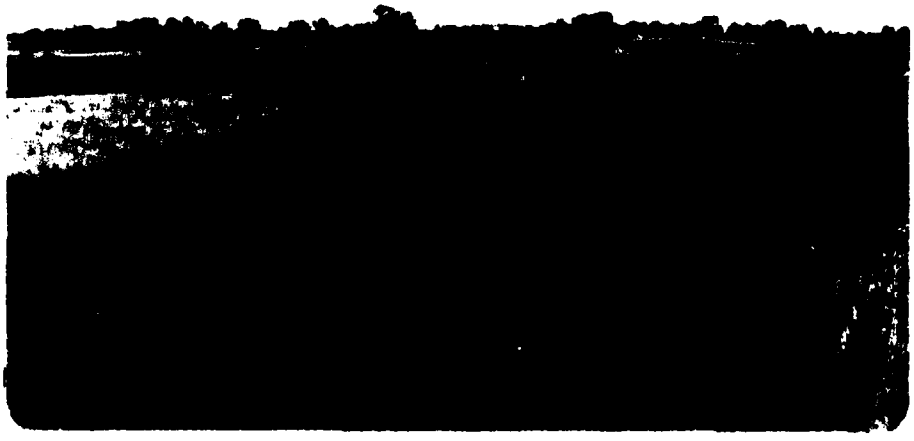


PHOTO NO. 15 - CREST AND DOWNSTREAM SLOPE OF LEFT LEG OF DAM.

PHOTO NO. 16 - UPSTREAM SLOPE OF MAIN DAM TAKEN FROM LEFT LEG OF DAM.

PHOTO NO. 17 - CREST OF MAIN DAM TAKEN FROM LEFT AT POINT OF CURVATURE WITH LEFT LEG.

PHOTO NO. 18 - DOWNSTREAM SLOPE OF MAIN DAM TAKEN FROM LEFT.

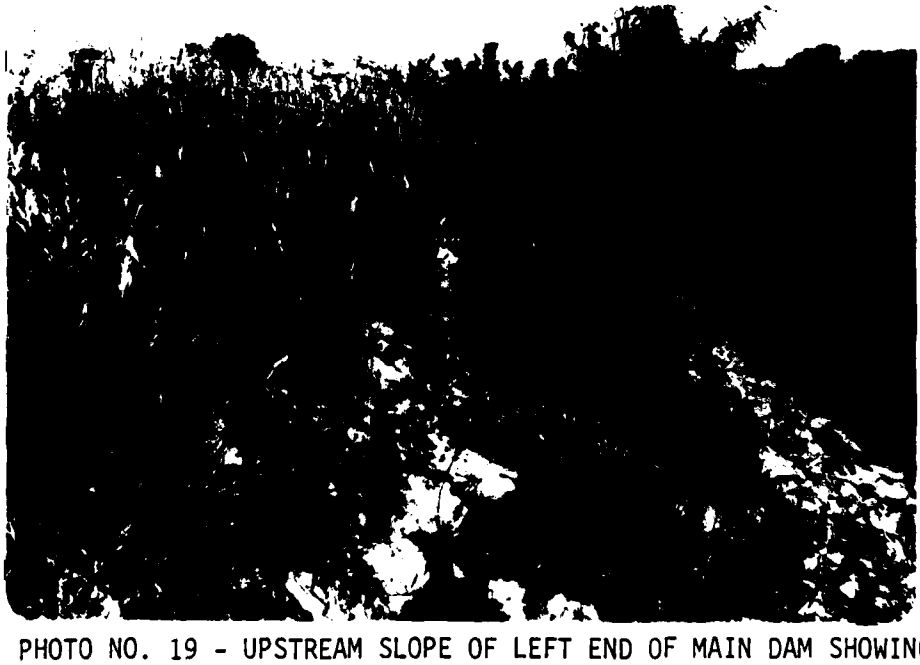


PHOTO NO. 19 - UPSTREAM SLOPE OF LEFT END OF MAIN DAM SHOWING EROSION AND DETERIORATION OF RIPRAP.

PHOTO NO. 20 - VIEW UPSTREAM WITH INTAKE TOWER TO WATER TREATMENT PLANT IN FOREGROUND.

PHOTO NO. 21 - VIEW DOWNSTREAM TAKEN FROM INTAKE TOWER LOCATION. BRIDGE AT EXTREME LEFT SPANS OUTLET CHANNEL.

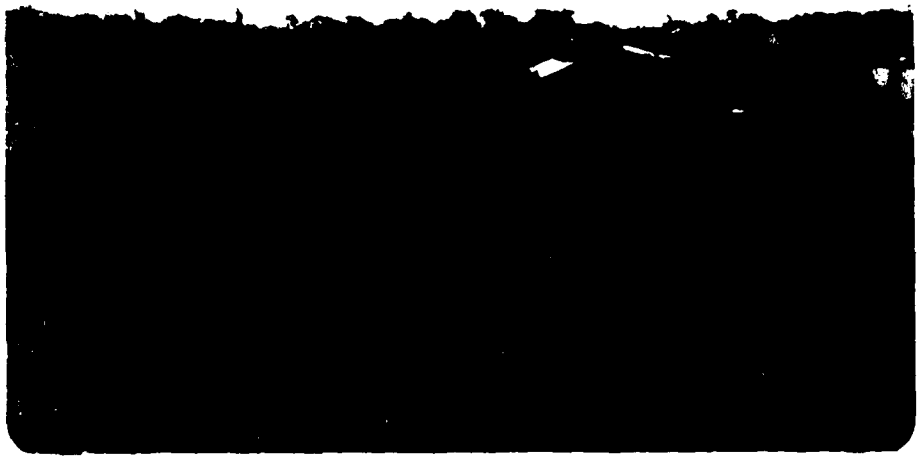


PHOTO NO. 22 - DOWNSTREAM SLOPE TAKEN FROM RIGHT.

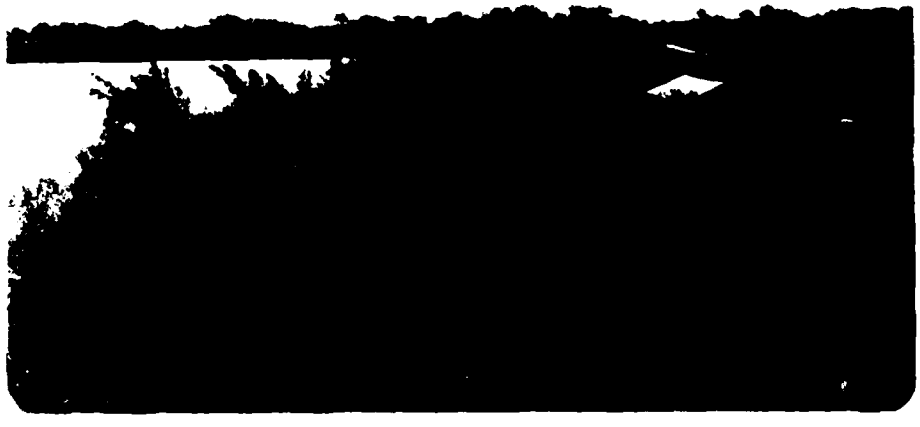


PHOTO NO. 23 - CREST OF MAIN DAM TAKEN FROM RIGHT. MAN IN BACKGROUND STANDING IN SAG OVER OR NEAR PIPE FROM INTAKE TOWER TO WATER TREATMENT PLANT.

PHOTO NO. 24 - VERTICAL DROP AND EROSION OF UPSTREAM FACE NEAR RIGHT END.

PHOTO NO. 25 - VIEW UPSTREAM IN EMERGENCY SPILLWAY. DIKE AND ROAD CROSSING SPILLWAY SHOWS IN CENTER OF PICTURE.

PHOTO NO. 26 - VIEW DOWNSTREAM IN EMERGENCY SPILLWAY.

PHOTO NO. 27 - VIEW OF UPSTREAM FACE TAKEN FROM RIGHT END.

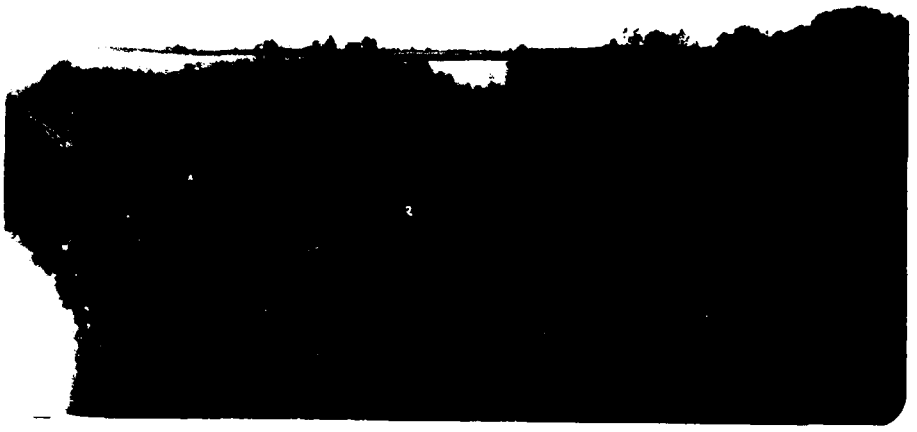
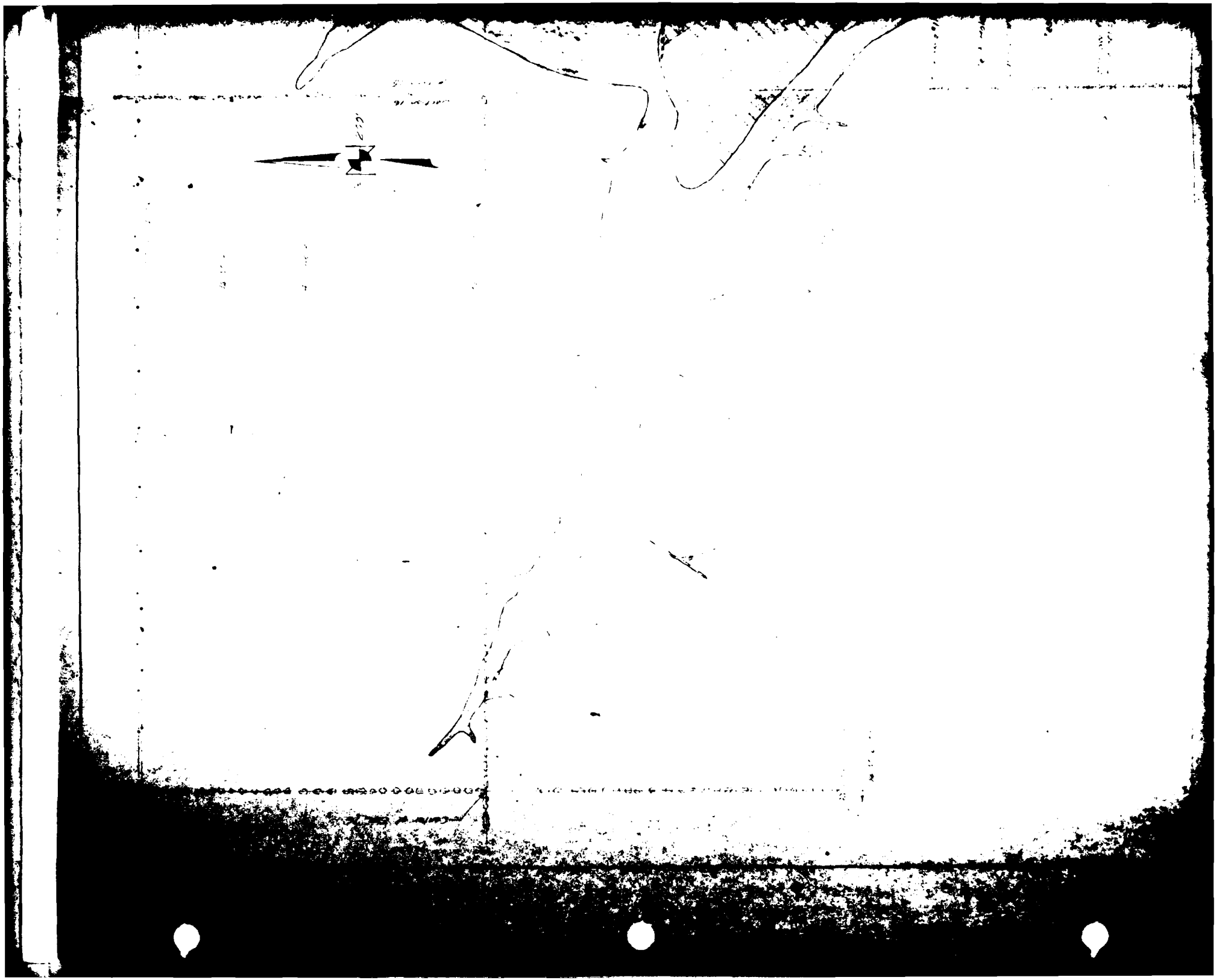
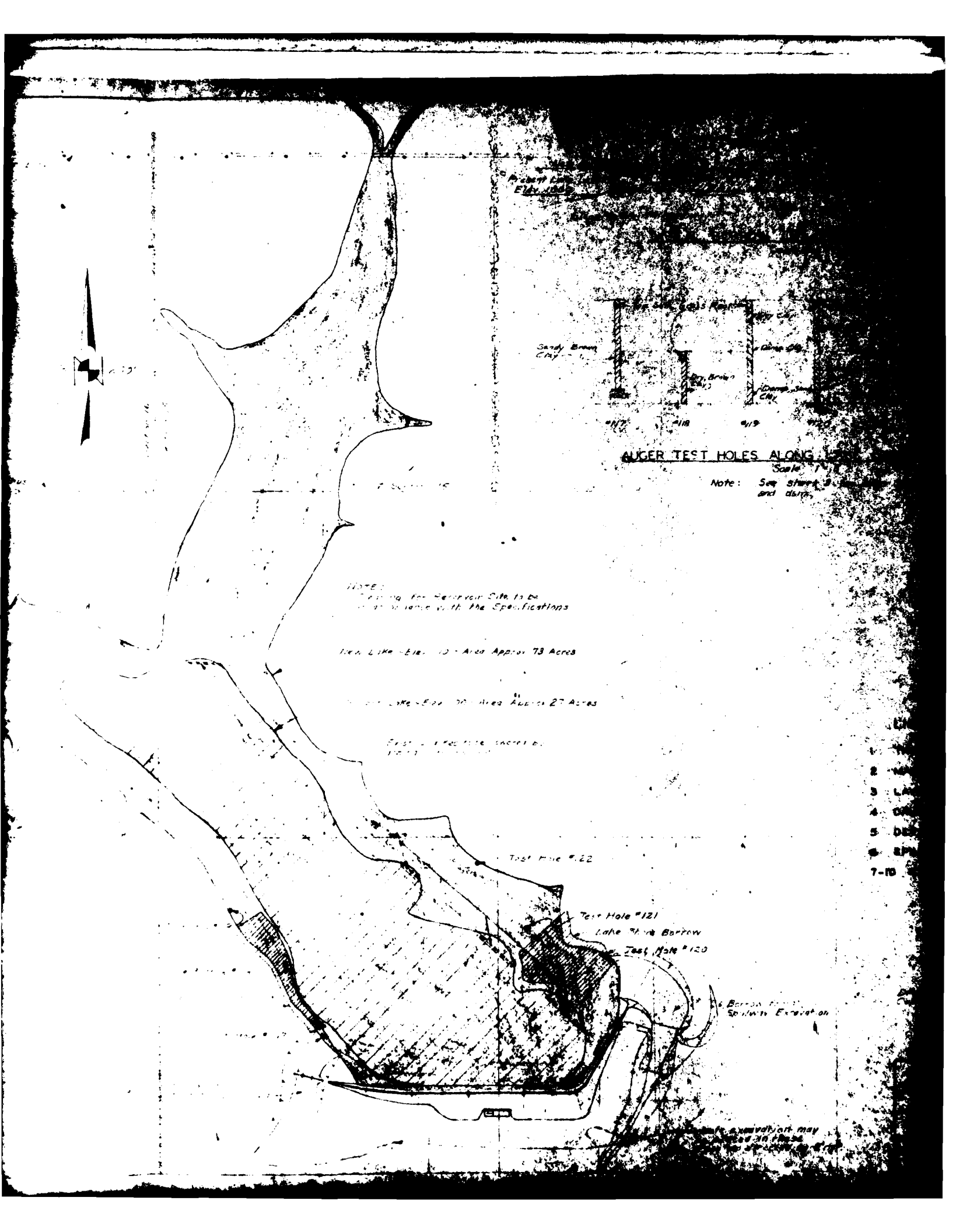


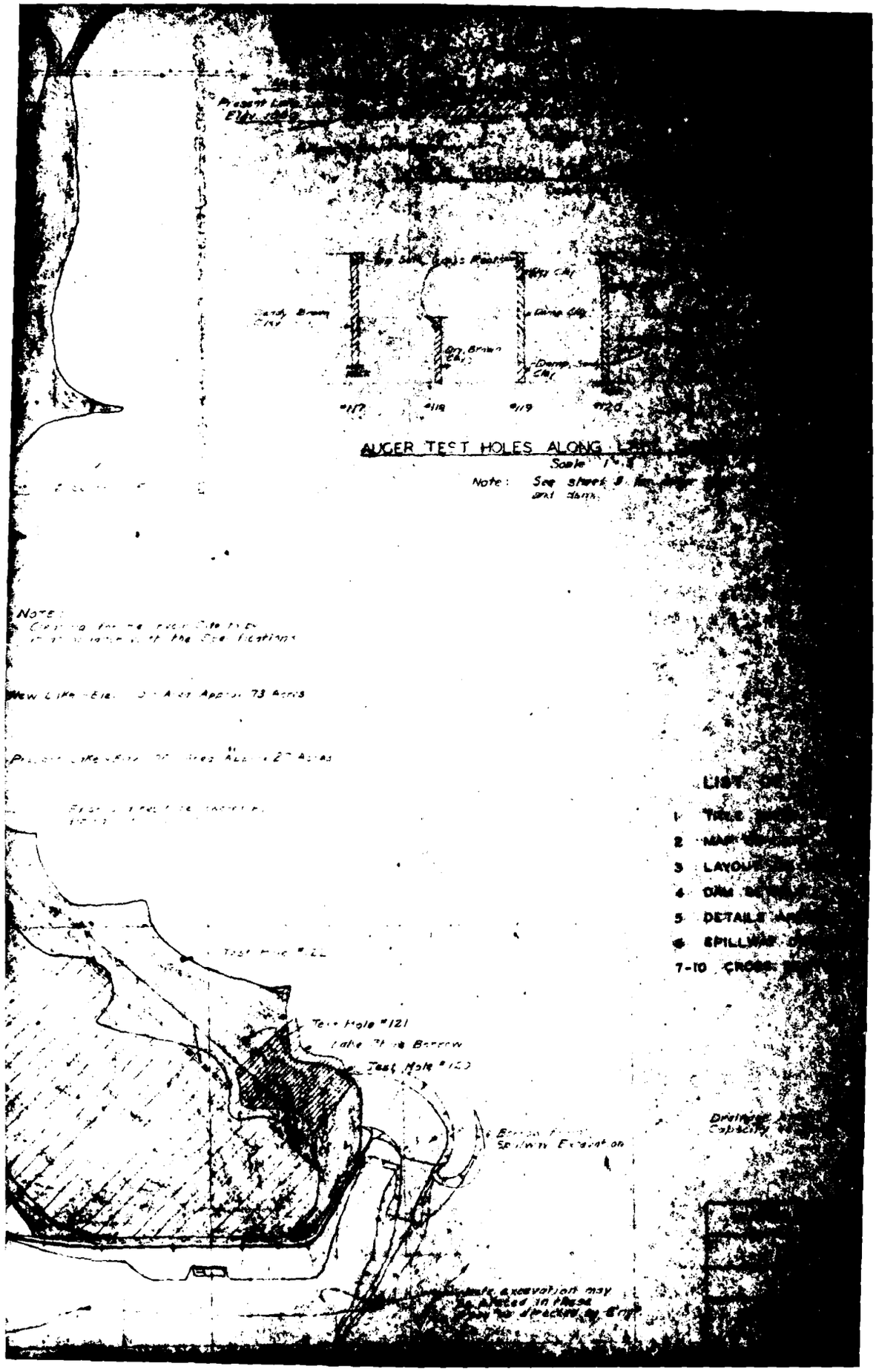
PHOTO NO. 28 - VIEW OF PRINCIPAL SPILLWAY CHUTE AND DOWNSTREAM CHANNEL TAKEN FROM HIGHWAY BRIDGE.

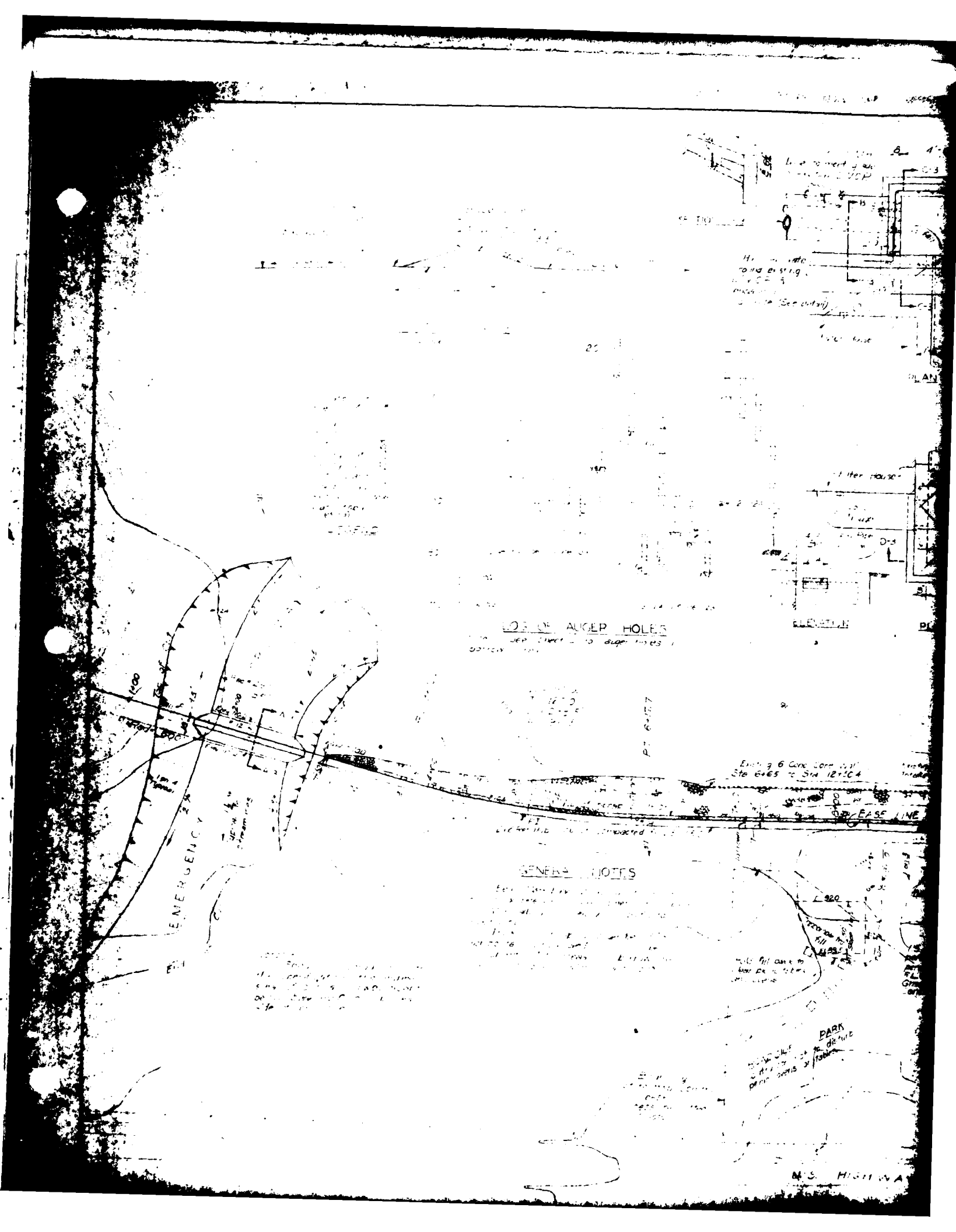
PHOTO NO. 29 - HOUSE IN FLOODPLAIN, 2 MILES DOWNSTREAM OF DAM.

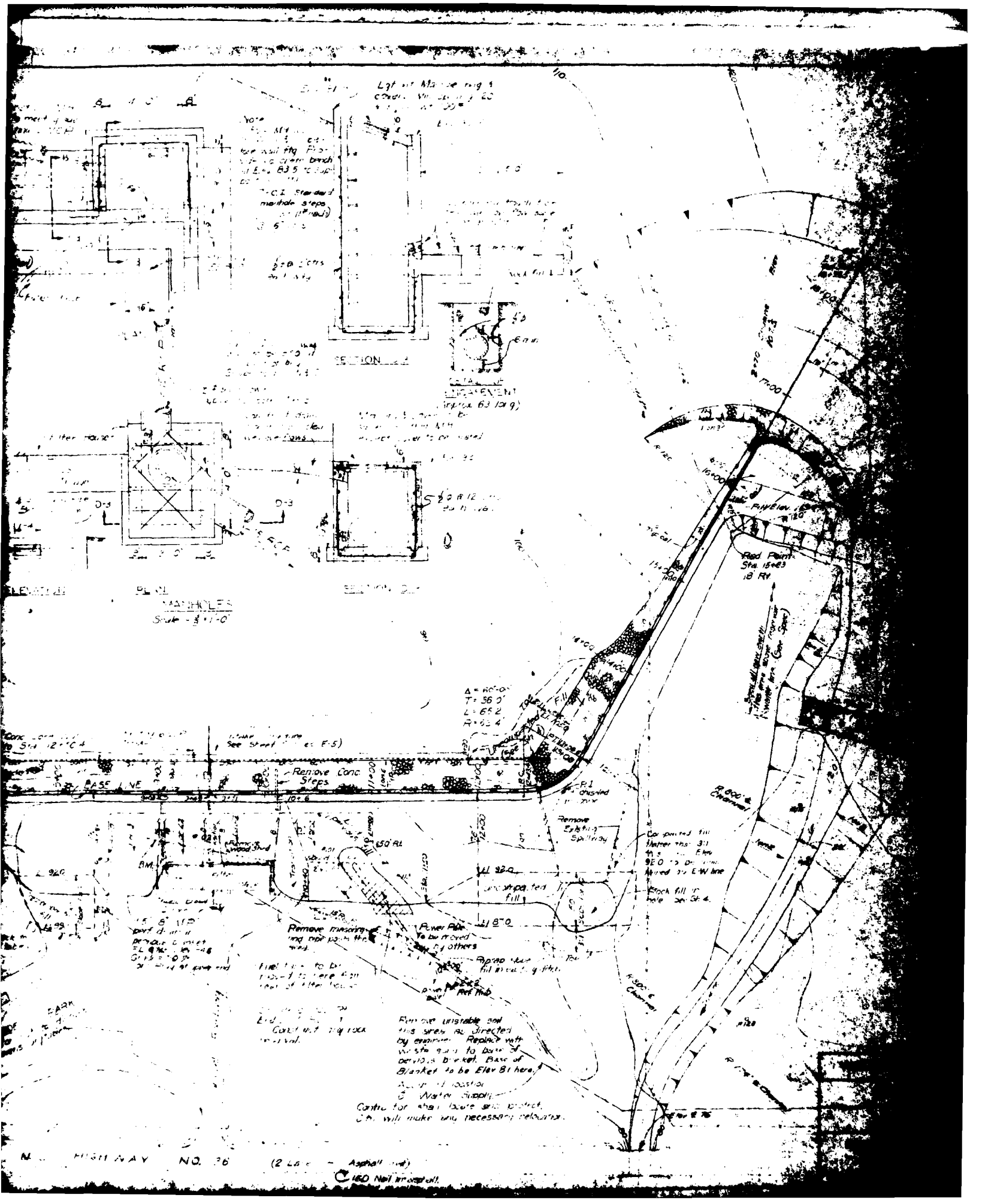
APPENDIX C
PROJECT PLATES

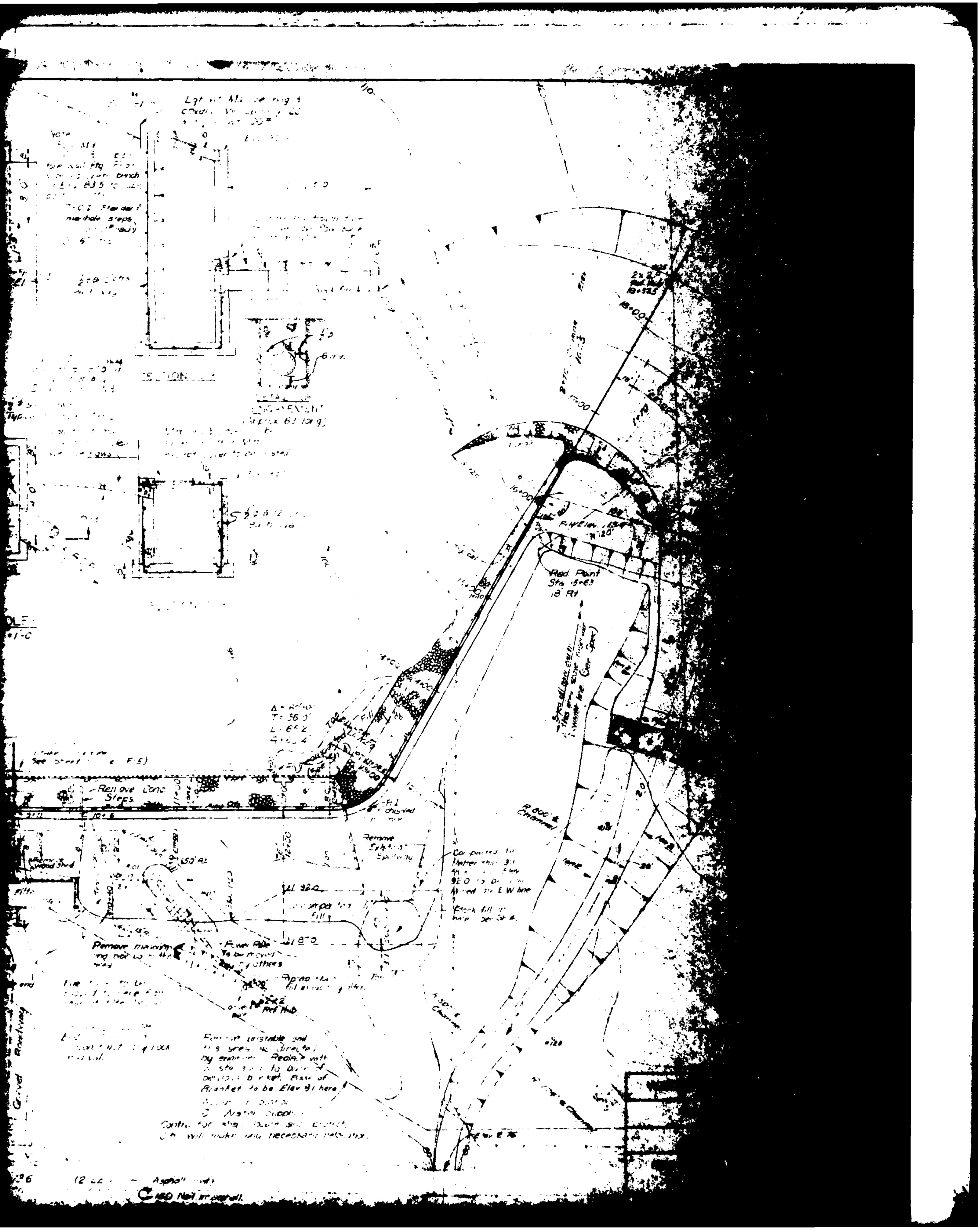



Sandy Brown Clay
#117
#118
#119
AUGER TEST HOLES ALONG
Scale
Note:
Test Hole #122
Test Hole #121
Lake Shore Borrow
Test Hole #120
Borrow
Shoreline Excavation

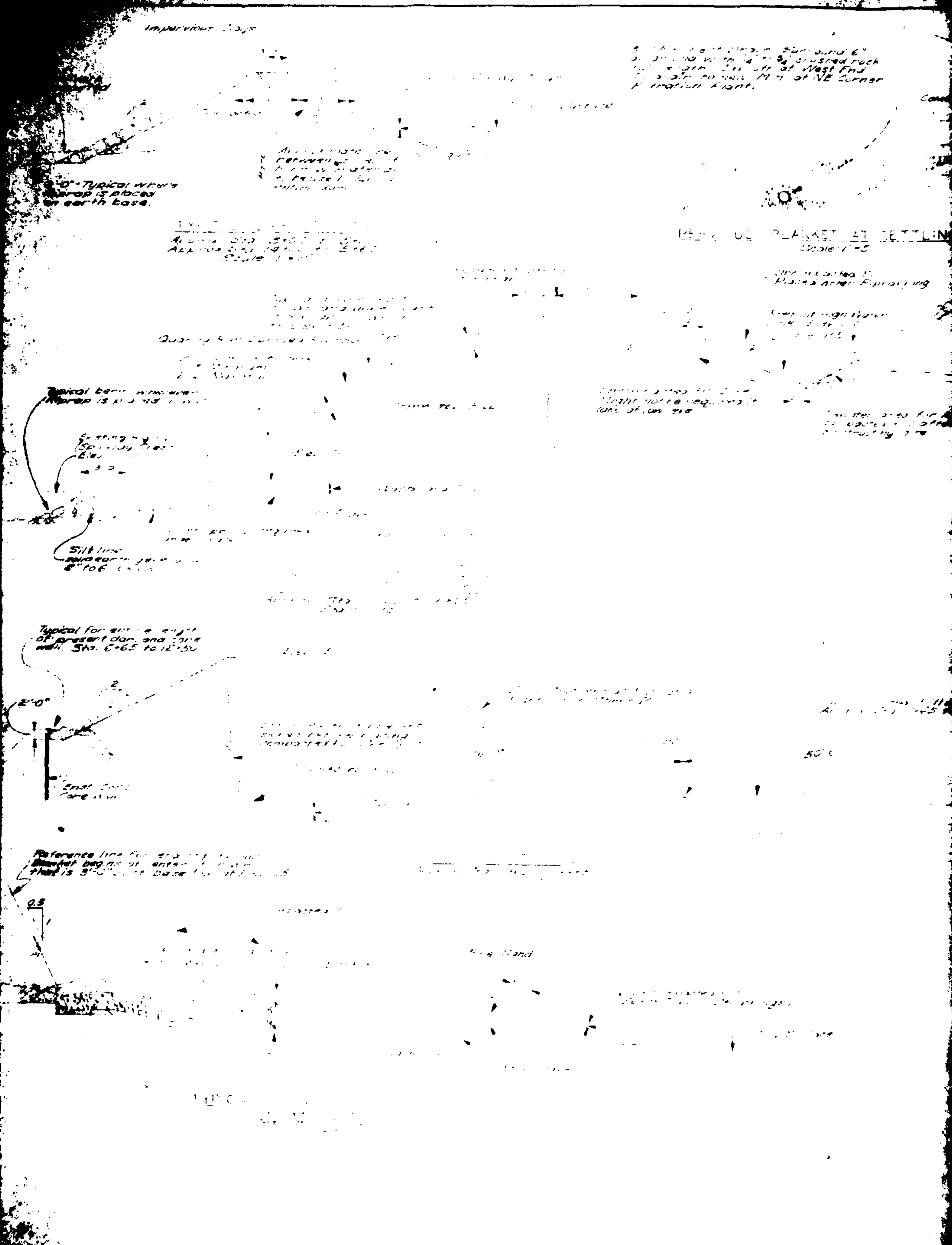

AUGER TEST HOLES ALONG
Note:
Test Hole #121
Test Hole #120
LIST


LOG OF AUGER HOLES
GENERAL NOTES
EMERGENCY
PARK
M.S. HIGHWAY

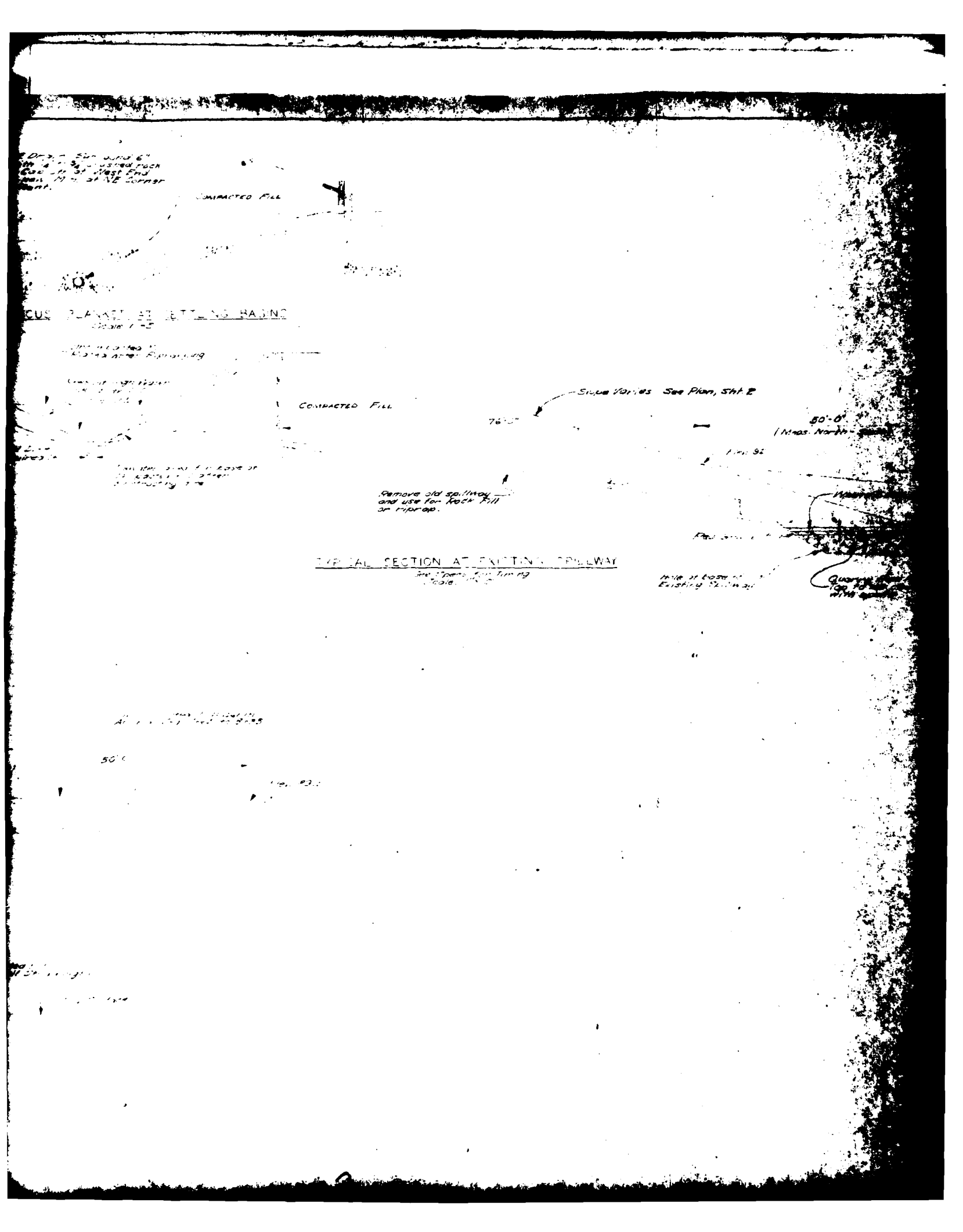

SECTION
MANHOLES
Scale - 3/4" = 1'-0"
Red Point
Sta. 15+83
18 Rt
Remove Conc. Steps
Remove existing pipe with the wood
Power Pole To be moved By others
Remove unstable soil this area as directed by engineer. Replace with waste soils to base of service backfill. Base of Blanket to be Elev 81 here.
Water Supply
Contr. for shall have site protect. Co. will make any necessary relocations.
HIGHWAY NO. 26 (2 Lane - Asphalt mat)
160 Nail in road all



Remove Conc Steps
Red. Point Sta. 15+63 18' Rt
F.W.Elev.
R 800' ℄ Channel
Remove Existing Spillway
Power Pole To be moved by others
2x2 Ref Hub
Rock fill
Blanket to be Elev 31 here
Asphalt
C 180 Neil in stairwell.

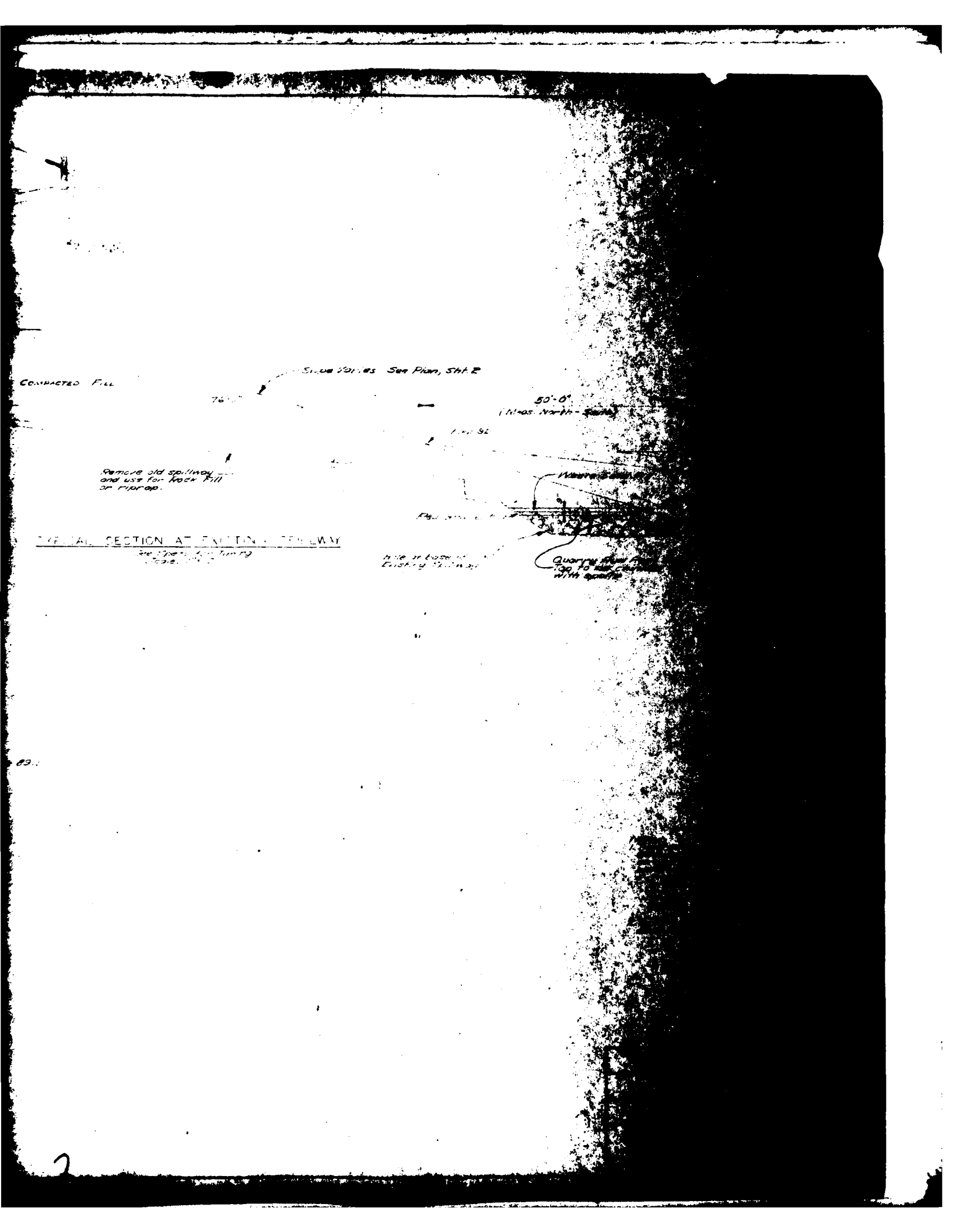


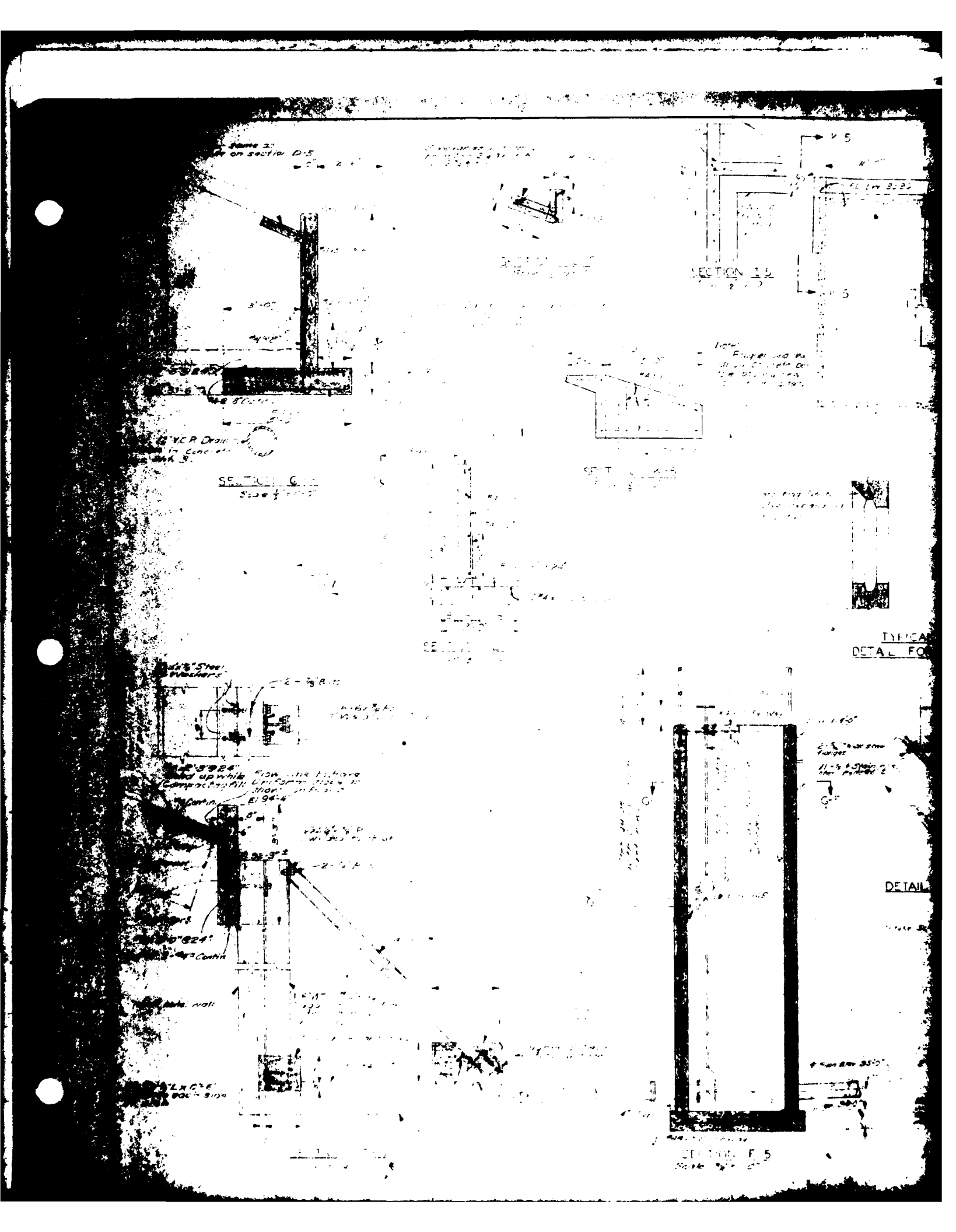
Impervious
2'-0" Typical where riprap is placed on earth base.
Typical berm where riprap is placed
Silt line
Typical for ... of present dam and core wall. Sta. 0+65 to 12+50
2'-0"
Reference line
0.5
Scale 1"=5'

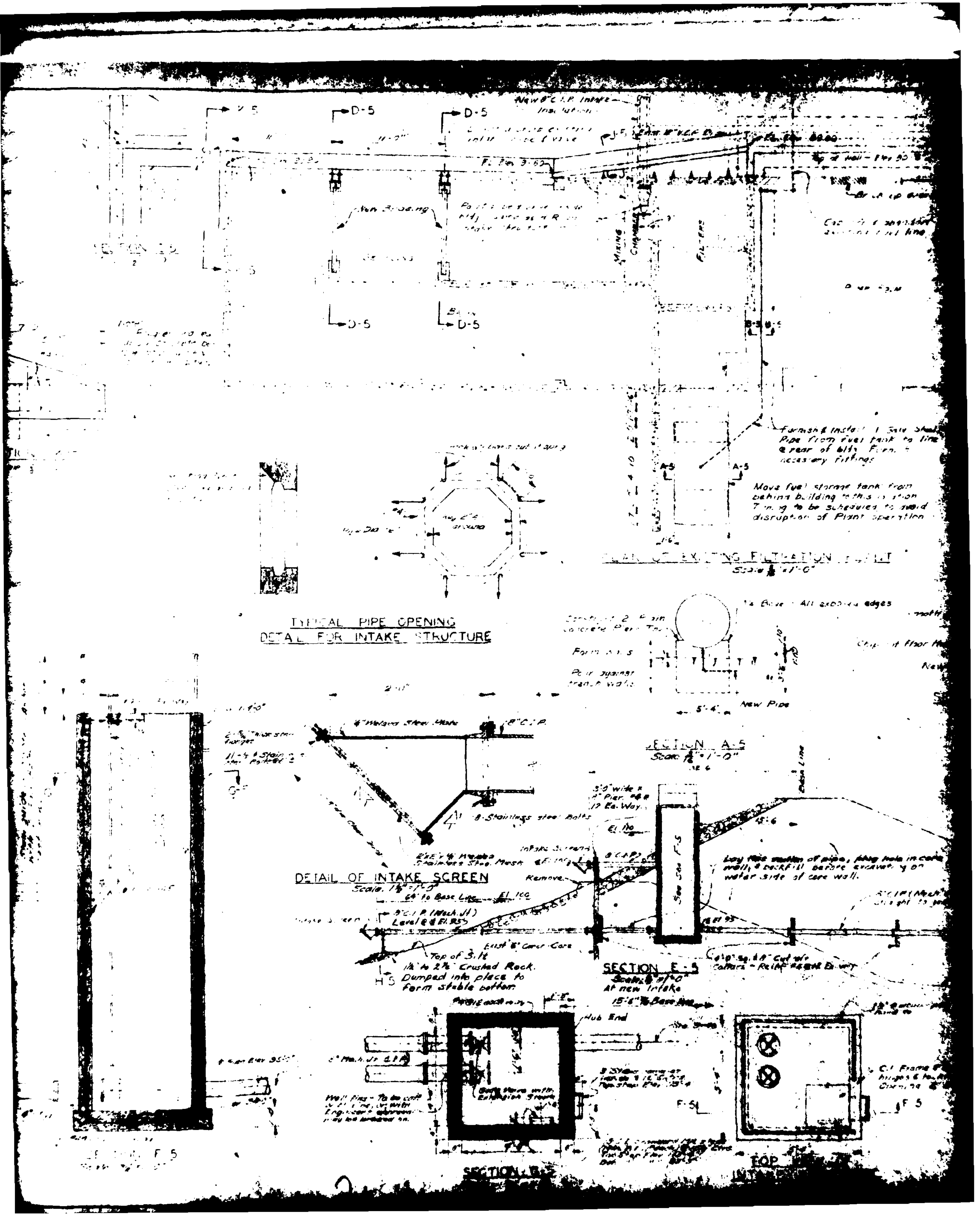


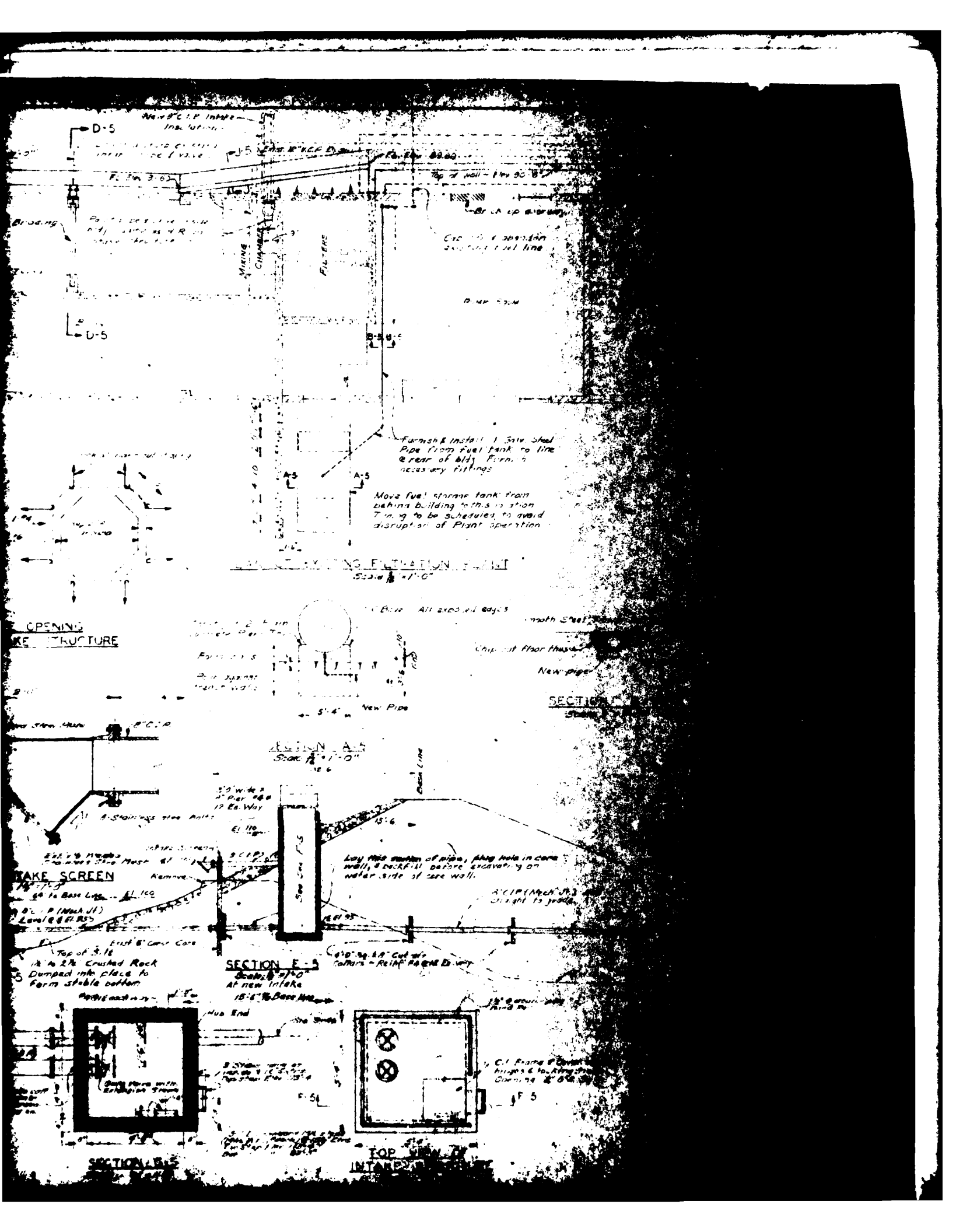
CUS PLANKET AT SETTLING BASINS
Scale 1"=5'

TYPICAL SECTION AT EXISTING SPILLWAY
Scale

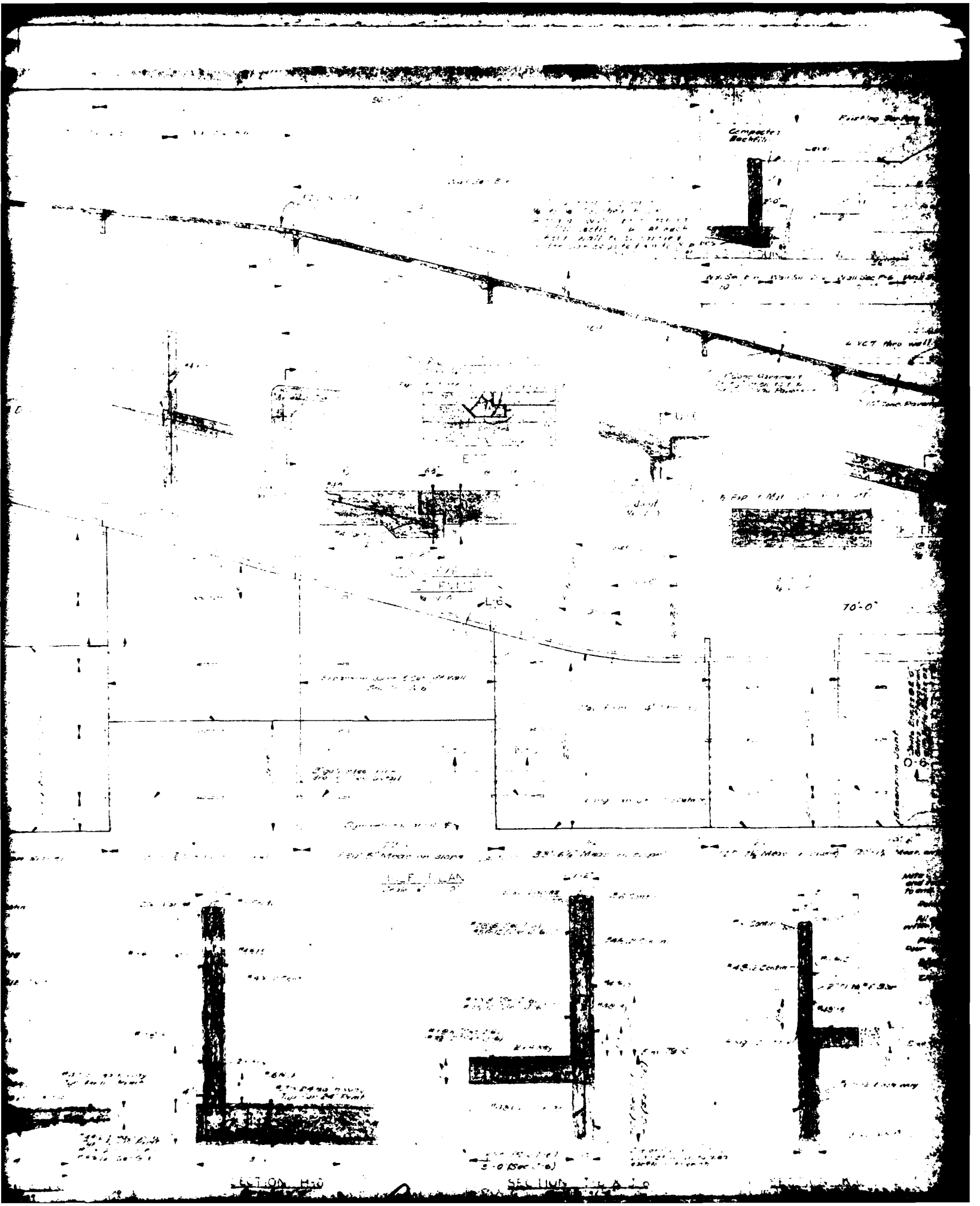

Compacted Fill
Slide Notes See Plan, Sht 2
50'-0"
Remove old spillway and use for rock fill or riprap.
Quarry

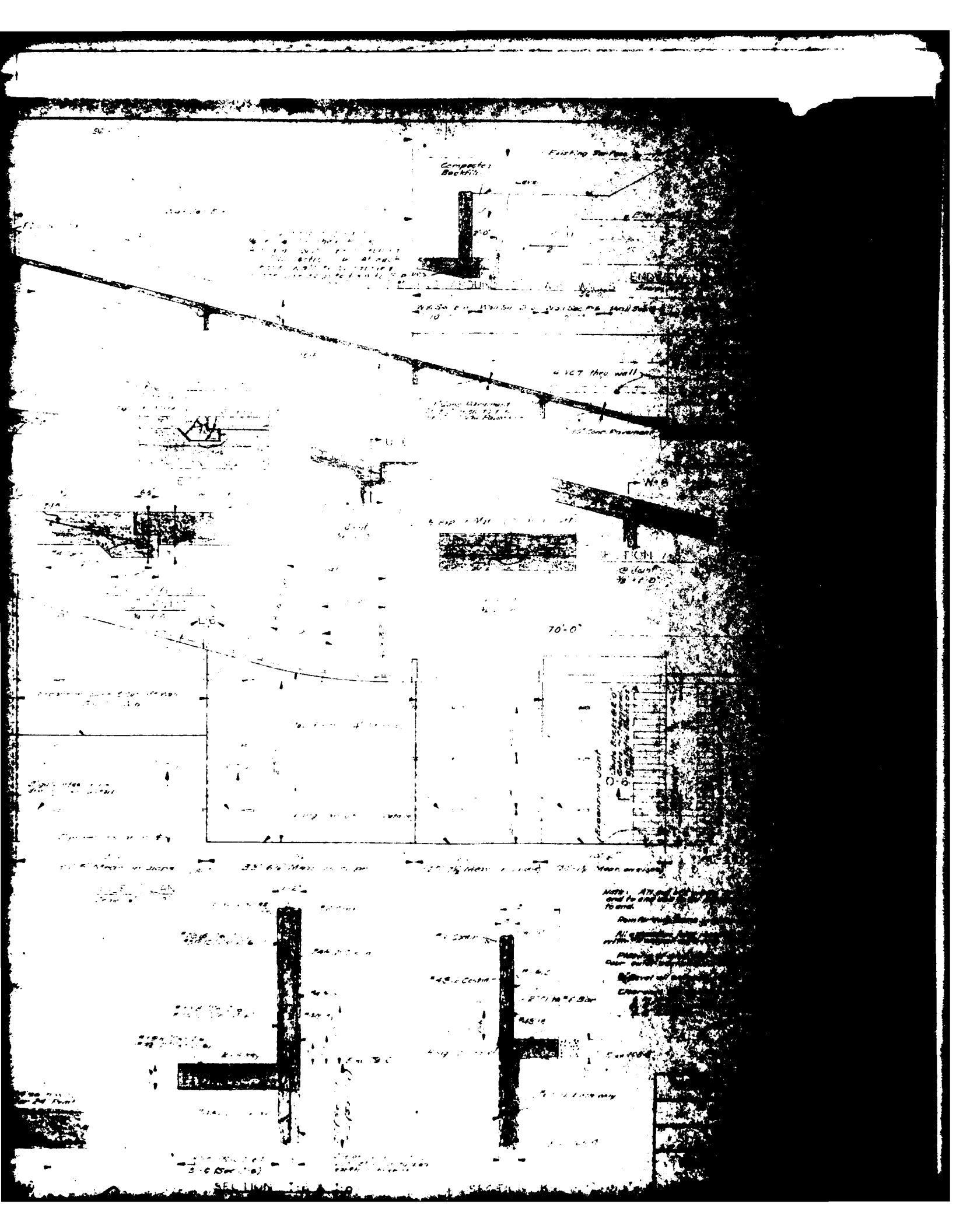

SECTION 1-1
SECTION C
SECTION E-5
DETAIL
TYPICAL

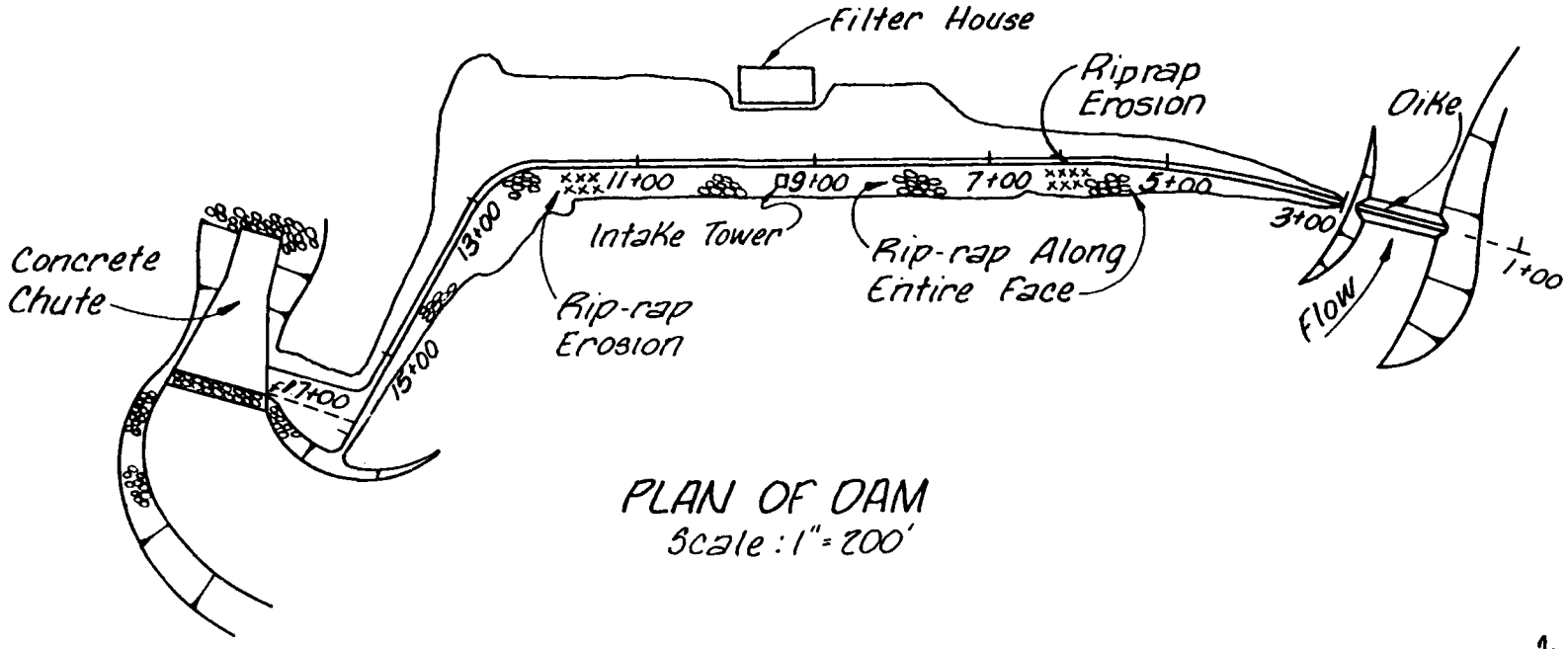

D-5
D-5
New 8" C.I.P. Intake
Insulation
New Bracing
Mixing Chamber
Filters
TYPICAL PIPE OPENING
DETAIL FOR INTAKE STRUCTURE
Furnish & install 1 Gal. Steel Pipe from fuel tank to line @ rear of bldg. Furn. necessary fittings
Move fuel storage tank from behind building to this station. Timing to be scheduled to avoid disruption of Plant operation
PLAN OF EXISTING FILTRATION PLANT
New Pipe
SECTION A-5
Scale 1/2" = 1'-0"
4" Welded Steel Plate
8" C.I.P.
8-Stainless steel Bolts
DETAIL OF INTAKE SCREEN
64' to Base Line
El. 100
Top of Silt
1 1/2" to 2 1/2" Crushed Rock. Dumped into place to Form stable bottom
Lay this section of pipe, plug hole in core wall, & backfill before excavating on water side of core wall.
Remove
SECTION E-5
At new Intake
15'-6" To Base line
Hub End
SECTION F-5
F-5
TOP


D-5
Mixing Chamber
Filters
Furnish & install 1 Sch. Steel Pipe from fuel tank to line @ rear of bldg. Furnish necessary fittings
Move fuel storage tank from behind building to this location Timing to be scheduled to avoid disruption of Plant operation
EXISTING FILTRATION PLANT
Scale 1/8" = 1'-0"
New Pipe
SECTION A-5
Scale 1/2" = 1'-0"
Base Line
Lay this section of pipe, plug hole in conc. wall, & backfill before excavating on water side of conc. wall.
SECTION E-5
Scale 1/2" = 1'-0"
At new intake
Top of S.B.
1/2 to 2" Crushed Rock Dumped into place to form stable bottom
SECTION F-5
TOP
INTAKE


Elev. 109.7
Const. Jt.
Cut off wall pour against undisturbed earth in trench
Elev. 104.0
SECTION
½" Expansion Jt. Mat.
Pour with Slab.
2x4x1'-6 Key each side of Block
Trowel to smooth finish, apply heavy coat of Asph. paint before placing adjacent slab.
PLAN
SECTION

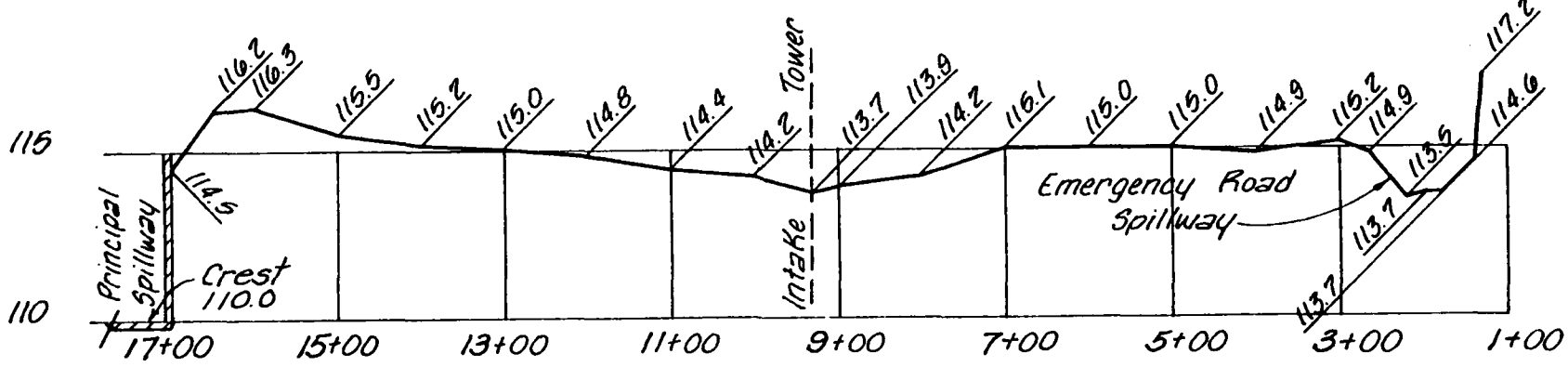

Compacted Backfill
70'-0"


Compacted Backfill
Existing Surface
4" VCT thro wall
70'-0"



PLAN OF DAM

Scale: 1" = 200'

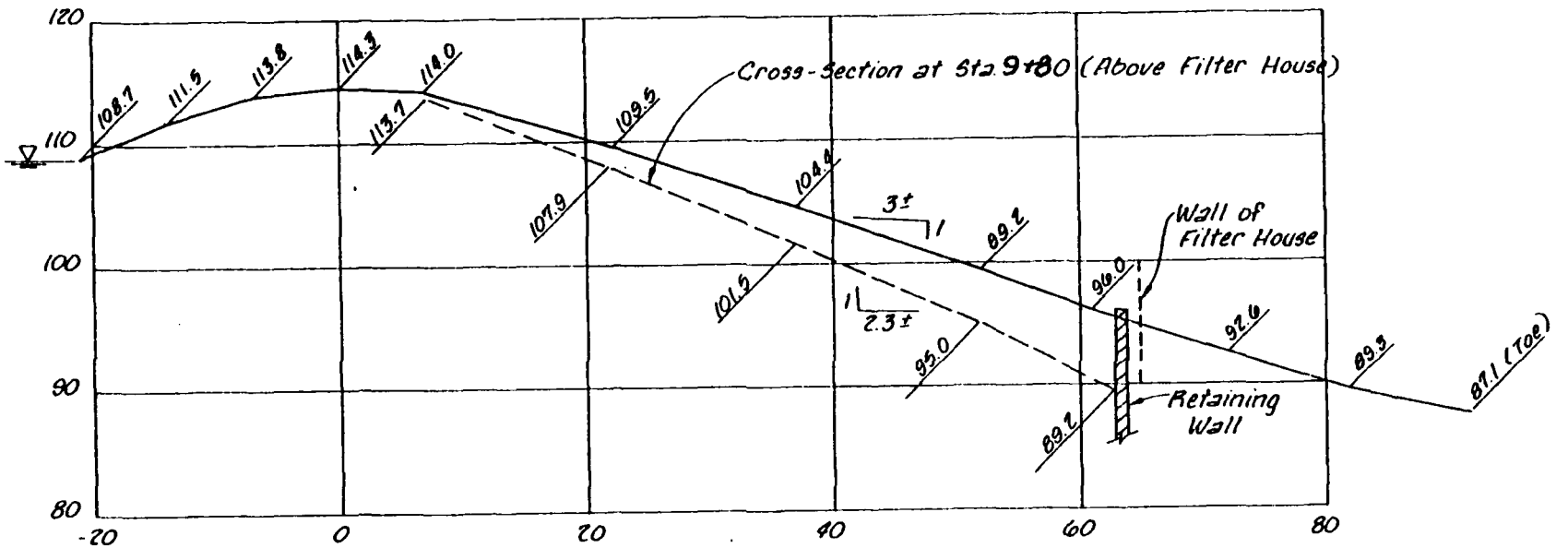


PROFILE ALONG CENTERLINE OF DAM

Scale: 1" = 200' H.

1" = 5' V.

PLATE C-6



CROSS-SECTION OF DAM AT STA. 10+30

Scale: 1" = 10'

PLATE C-7

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See this Section).

   a. Forty-eight hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Chillicothe, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 4 March 1980. The forty-eight hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 1.78 square miles (1,141 acres).

   c. Time of concentration of runoff = 56 minutes (computed from the "Kirpich" formula). This compares to 58 minutes as computed from California Culverts Practice, California Highways and Public Works.

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the one percent probabilistic precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway.

   e. The total forty-eight hour storm duration losses for the one percent probabilistic storm were 2.28 inches. The total losses for the PMF storm were 1.02 inches. These data are based on SCS runoff curve No. 81 and No. 92 for antecedent moisture conditions SCS AMC II and AMC III respectively. The watershed is composed of primarily SCS soil groups C and D (Lagonda-Lamoni-Adair Soil Association). The watershed is approximately 60% under cultivation in row crops, small grain, and legumes on partially contoured or terraced land. The remainder is pasture and woodland.

   f. Average soil loss rates = 0.02 inch per hour approximately (For PMF storm, AMC III).

2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.

   a. The principal spillway (concrete chute) rating was developed using the Corps of Engineers Water Surface Profile HEC-2 computer program assuming critical depth at the chute weir-crest.

   b. The emergency spillway (earthen channel with dike) rating was developed using road-overflow methods and coefficients founds in USGS TWRI, Bk 3, Ch. A5 "Measurement of Peak Discharge at Dams by Indirect Methods".

c. The flows over the dam were determined by using the dam overtopping analyses (irregular top of dam) within the HEC-1 (Dam Safety Version) program.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input, output and plotted hydrographs are attached in this Section.

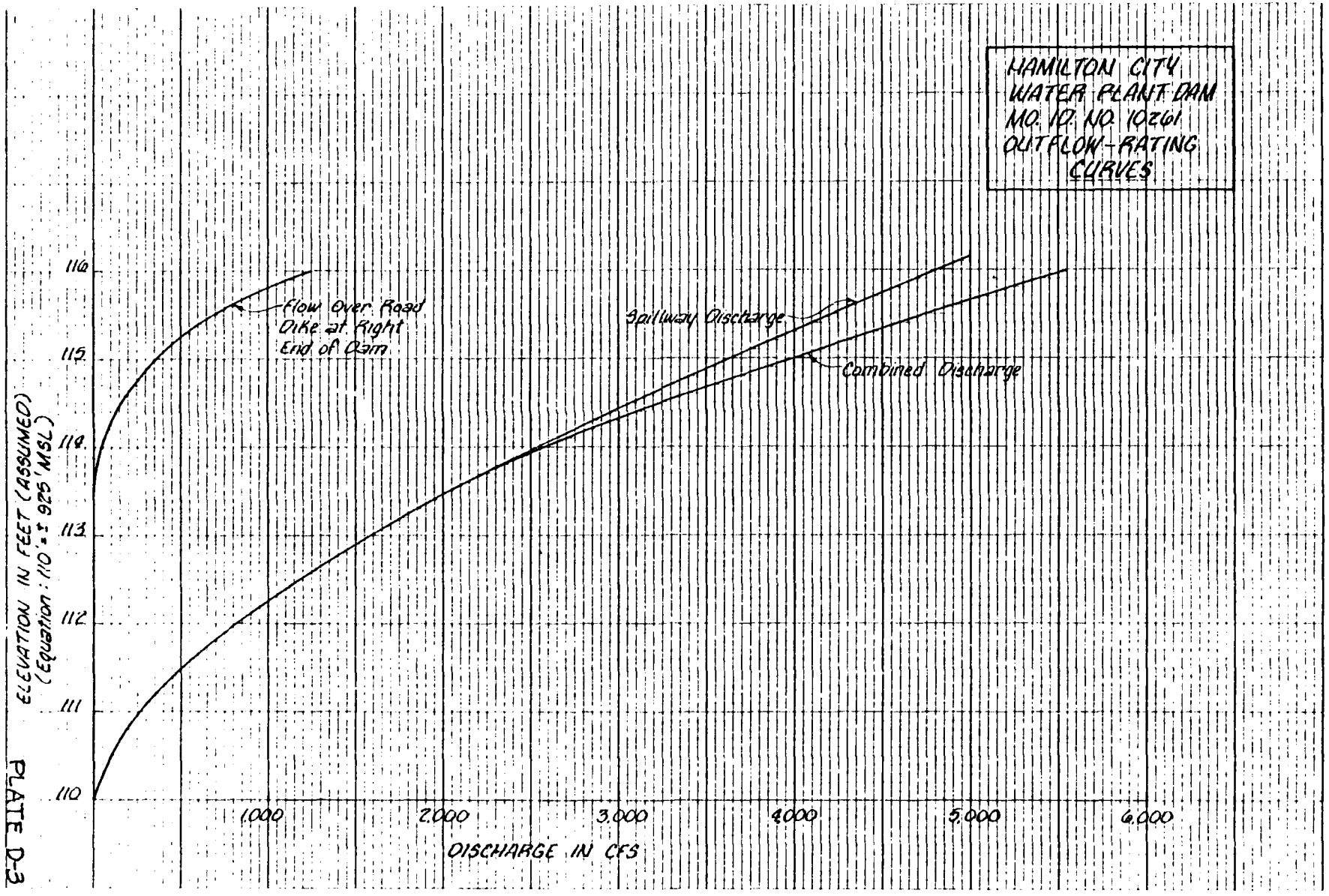

HAMILTON CITY
WATER PLANT DAM
MO. ID. NO. 10261
OUTFLOW-RATING
CURVES
Flow Over Road
Dike at Right
End of Dam
Spillway Discharge
Combined Discharge
ELEVATION IN FEET (ASSUMED)
(Equation: 110' = 925' MSL)
116
115
114
113
112
111
110
1,000
2,000
3,000
4,000
5,000
6,000
DISCHARGE IN CFS

PLATE D-3

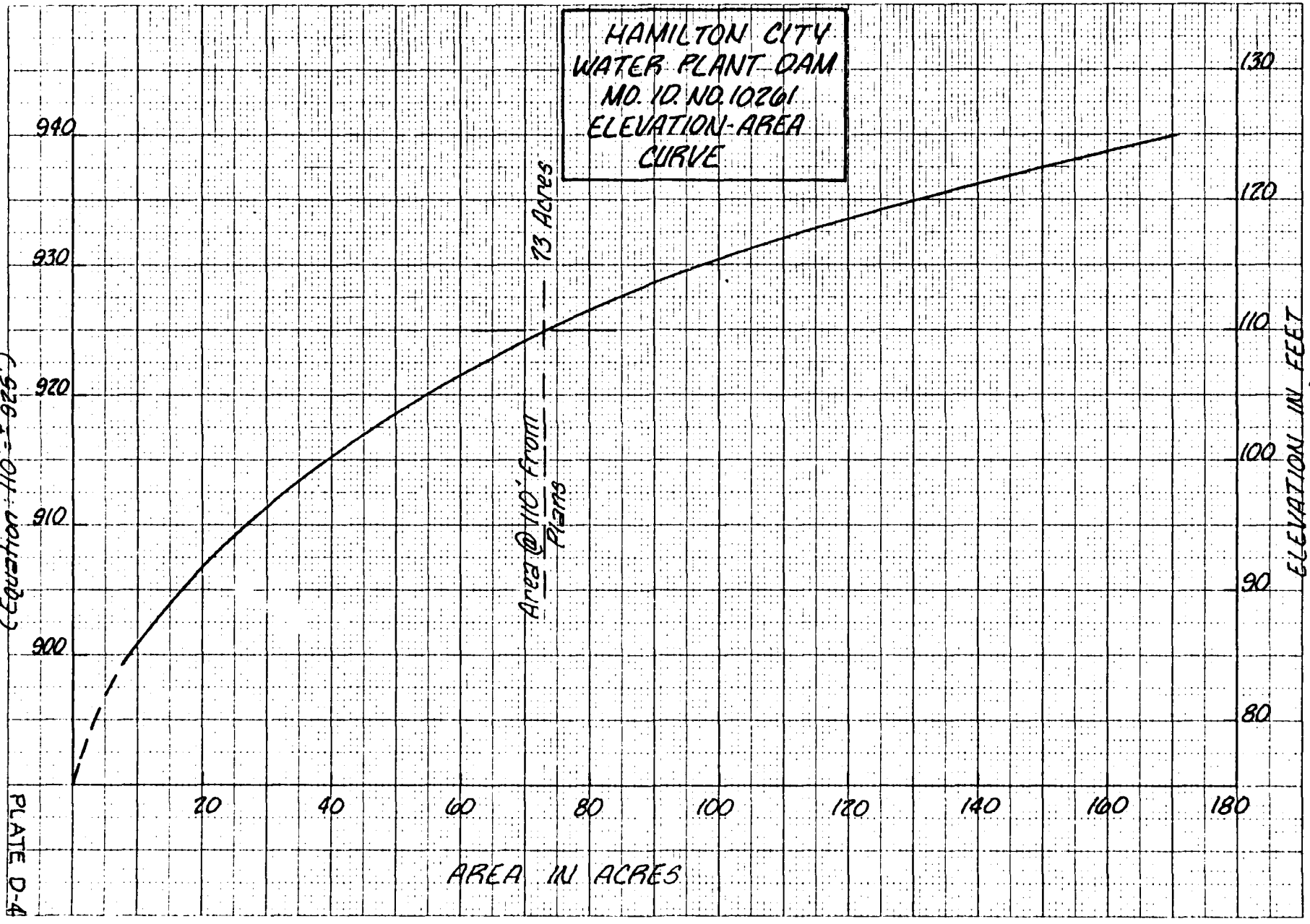


PLATE D-4

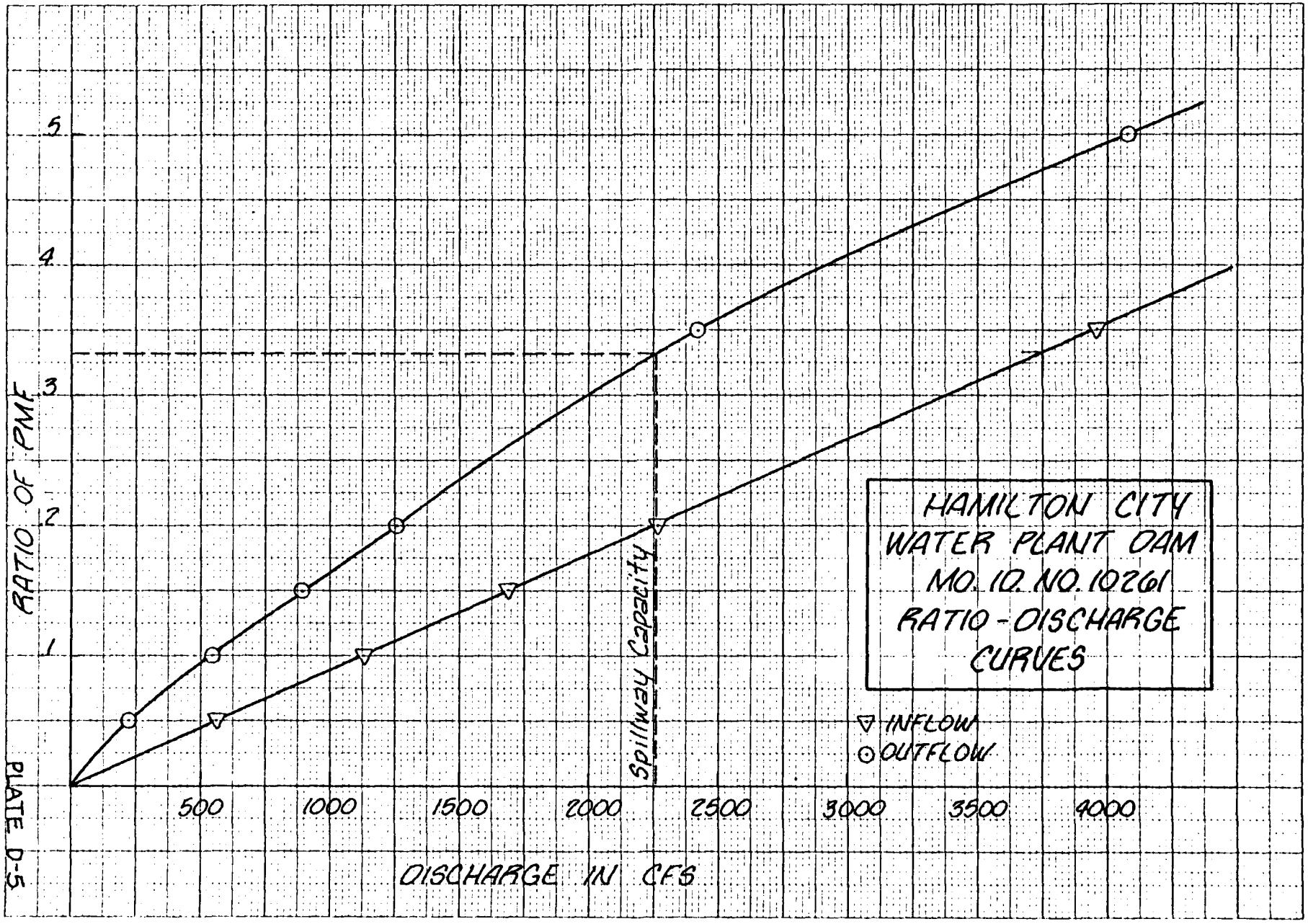


PLATE D-5

LISTING OF CARD INPUT DATA

```
A1                          HAMILTON CITY WATER PLANT DAM/MO ID NO 10261
A2       SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
A3                H & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR
B    2880000000000000010                                  000000000000000000000003
B1     5
J      10000000800000001
J1   .0500000.1000000.1500000.2000000.3500000.5000000.75000001.0
K      000000001                    000000000000000000000001
K1      CALCULATION OF INFLOW HYDRO TO RESERVOIR 10261
M      1000000020001.783        0001.783000001.0                    00000001
P      0000024.200000102000001210000013000000140
T                                                          -1.0   -92.0
W2      0000.562
X      0    -.0100000001
K      100000002                    000C000200000000000000001
K1      ROUTED FLOWS THRU RESERVOIR 10261
Y                           0000000100000001
Y1     1                                                -110.0      -1
Y4 110.0000110.5000111.0000111.5000112.0000113.0000113.5000114.0000115.0000116.0
Y5     000000100000002500000050000C0080000001550000020500000258000004010000055 50
$A     000000003000000160000003900000073000000980000013000000171
$E    750000008000000090000001000000011000000115000001200000012 5
$$ 110.0
$D 113.7000002.8000001.500001200
$L     000000044000002000000032500000675000008250000101500001100000012000000130 0
$V 113.7000113.9000114.2000114.4000115.0000115.0000115.1000115.2000115.5000116.3
K      99
A
A
A
A
A
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE= 80/07/25.
     TIME= 13.29.56.
```

HAMILTON CITY WATER PLANT DAM/MO ID NO 10261
SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
H & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 8 LRTIO= 1

RTIOS= .05 .10 .15 .20 .35 .50 .75 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDRO TO RESERVOIR 10261

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	1.78	0.00	1.78	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.20	102.00	121.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-92.00	0.00	0.00

CURVE NO = -92.00 WETNESS = -1.00 EFFECT CN = 92.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .56

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 19 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .56 VOL= 1.00

204.	670.	1205.	1331.	1157.	829.	515.	342.	227.	148.
97.	64.	42.	27.	18.	13.	8.	5.	1.	

0 END-OF-PERIOD FLOW

PLATE D-7

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.00	0.00	.00	0.	1.02	.10	145	.02	.02	.00	22.
1.01	.20	2	.00	0.00	.00	0.	1.02	.20	146	.02	.02	.00	35.
1.01	.30	3	.00	0.00	.00	0.	1.02	.30	147	.02	.02	.00	59.
1.01	.40	4	.00	0.00	.00	0.	1.02	.40	148	.02	.02	.00	85.
1.01	.50	5	.00	0.00	.00	0.	1.02	.50	149	.02	.02	.00	108.
1.01	1.00	6	.00	0.00	.00	0.	1.02	1.00	150	.02	.02	.00	125.
1.01	1.10	7	.00	0.00	.00	0.	1.02	1.10	151	.02	.02	.00	135.
1.01	1.20	8	.00	0.00	.00	0.	1.02	1.20	152	.02	.02	.00	142.
1.01	1.30	9	.00	0.00	.00	0.	1.02	1.30	153	.02	.02	.00	147.
1.01	1.40	10	.00	0.00	.00	0.	1.02	1.40	154	.02	.02	.00	150.
1.01	1.50	11	.00	0.00	.00	0.	1.02	1.50	155	.02	.02	.00	152.
1.01	2.00	12	.00	0.00	.00	0.	1.02	2.00	156	.02	.02	.00	153.
1.01	2.10	13	.00	0.00	.00	0.	1.02	2.10	157	.02	.02	.00	154.
1.01	2.20	14	.00	0.00	.00	0.	1.02	2.20	158	.02	.02	.00	155.
1.01	2.30	15	.00	0.00	.00	0.	1.02	2.30	159	.02	.02	.00	155.
1.01	2.40	16	.00	0.00	.00	0.	1.02	2.40	160	.02	.02	.00	156.
1.01	2.50	17	.00	0.00	.00	0.	1.02	2.50	161	.02	.02	.00	156.
1.01	3.00	18	.00	0.00	.00	0.	1.02	3.00	162	.02	.02	.00	156.
1.01	3.10	19	.00	0.00	.00	0.	1.02	3.10	163	.02	.02	.00	156.
1.01	3.20	20	.00	0.00	.00	0.	1.02	3.20	164	.02	.02	.00	157.
1.01	3.30	21	.00	0.00	.00	0.	1.02	3.30	165	.02	.02	.00	157.
1.01	3.40	22	.00	0.00	.00	0.	1.02	3.40	166	.02	.02	.00	157.
1.01	3.50	23	.00	0.00	.00	0.	1.02	3.50	167	.02	.02	.00	157.
1.01	4.00	24	.00	0.00	.00	0.	1.02	4.00	168	.02	.02	.00	157.
1.01	4.10	25	.00	0.00	.00	0.	1.02	4.10	169	.02	.02	.00	157.
1.01	4.20	26	.00	0.00	.00	0.	1.02	4.20	170	.02	.02	.00	157.
1.01	4.30	27	.00	0.00	.00	0.	1.02	4.30	171	.02	.02	.00	158.
1.01	4.40	28	.00	0.00	.00	0.	1.02	4.40	172	.02	.02	.00	158.
1.01	4.50	29	.00	0.00	.00	0.	1.02	4.50	173	.02	.02	.00	158.
1.01	5.00	30	.00	0.00	.00	0.	1.02	5.00	174	.02	.02	.00	158.
1.01	5.10	31	.00	0.00	.00	0.	1.02	5.10	175	.02	.02	.00	158.
1.01	5.20	32	.00	0.00	.00	0.	1.02	5.20	176	.02	.02	.00	158.
1.01	5.30	33	.00	0.00	.00	0.	1.02	5.30	177	.02	.02	.00	158.
1.01	5.40	34	.00	0.00	.00	0.	1.02	5.40	178	.02	.02	.00	158.
1.01	5.50	35	.00	0.00	.00	0.	1.02	5.50	179	.02	.02	.00	158.
1.01	6.00	36	.00	0.00	.00	0.	1.02	6.00	180	.02	.02	.00	159.
1.01	6.10	37	.01	0.00	.01	0.	1.02	6.10	181	.13	.12	.01	179.
1.01	6.20	38	.01	0.00	.01	0.	1.02	6.20	182	.13	.12	.01	245.
1.01	6.30	39	.01	0.00	.01	0.	1.02	6.30	183	.13	.12	.01	365.
1.01	6.40	40	.01	0.00	.01	0.	1.02	6.40	184	.13	.12	.00	497.
1.01	6.50	41	.01	0.00	.01	0.	1.02	6.50	185	.13	.12	.00	612.
1.01	7.00	42	.01	0.00	.01	0.	1.02	7.00	186	.13	.12	.00	696.
1.01	7.10	43	.01	0.00	.01	0.	1.02	7.10	187	.13	.12	.00	748.
1.01	7.20	44	.01	0.00	.01	0.	1.02	7.20	188	.13	.12	.00	783.
1.01	7.30	45	.01	0.00	.01	0.	1.02	7.30	189	.13	.12	.00	807.
1.01	7.40	46	.01	0.00	.01	0.	1.02	7.40	190	.13	.12	.00	824.
1.01	7.50	47	.01	.00	.01	0.	1.02	7.50	191	.13	.12	.00	835.
1.01	8.00	48	.01	.00	.01	0.	1.02	8.00	192	.13	.12	.00	842.
1.01	8.10	49	.01	.00	.01	0.	1.02	8.10	193	.13	.12	.00	848.
1.01	8.20	50	.01	.00	.01	1.	1.02	8.20	194	.13	.12	.00	852.
1.01	8.30	51	.01	.00	.01	1.	1.02	8.30	195	.13	.12	.00	855.
1.01	8.40	52	.01	.00	.01	2.	1.02	8.40	196	.13	.13	.00	857.
1.01	8.50	53	.01	.00	.01	3.	1.02	8.50	197	.13	.13	.00	859.
1.01	9.00	54	.01	.00	.01	4.	1.02	9.00	198	.13	.13	.00	861.
1.01	9.10	55	.01	.00	.01	5.	1.02	9.10	199	.13	.13	.00	862.
1.01	9.20	56	.01	.00	.01	7.	1.02	9.20	200	.13	.13	.00	862.
1.01	9.30	57	.01	.00	.01	8.	1.02	9.30	201	.13	.13	.00	863.
1.01	9.40	58	.01	.00	.01	9.	1.02	9.40	202	.13	.13	.00	864.
1.01	9.50	59	.01	.00	.01	10.	1.02	9.50	203	.13	.13	.00	865.
1.01	10.00	60	.01	.00	.01	11.	1.02	10.00	204	.13	.13	.00	865.

1.01	10.10	61	.01	.00	.01	13.	1.02	10.10	205	.13	.13	.00	866.
1.01	10.20	62	.01	.00	.01	14.	1.02	10.20	206	.13	.13	.00	866.
1.01	10.30	63	.01	.00	.01	15.	1.02	10.30	207	.13	.13	.00	867.
1.01	10.40	64	.01	.00	.01	16.	1.02	10.40	208	.13	.13	.00	868.
1.01	10.50	65	.01	.00	.01	17.	1.02	10.50	209	.13	.13	.00	868.
1.01	11.00	66	.01	.00	.01	18.	1.02	11.00	210	.13	.13	.00	869.
1.01	11.10	67	.01	.00	.01	19.	1.02	11.10	211	.13	.13	.00	869.
1.01	11.20	68	.01	.00	.01	20.	1.02	11.20	212	.13	.13	.00	869.
1.01	11.30	69	.01	.00	.01	21.	1.02	11.30	213	.13	.13	.00	870.
1.01	11.40	70	.01	.00	.01	21.	1.02	11.40	214	.13	.13	.00	870.
1.01	11.50	71	.01	.00	.01	22.	1.02	11.50	215	.13	.13	.00	871.
1.01	12.00	72	.01	.00	.01	23.	1.02	12.00	216	.13	.13	.00	871.
1.01	12.10	73	.03	.01	.02	26.	1.02	12.10	217	.41	.41	.00	928.
1.01	12.20	74	.03	.01	.02	33.	1.02	12.20	218	.41	.41	.00	1117.
1.01	12.30	75	.03	.01	.02	45.	1.02	12.30	219	.41	.41	.00	1456.
1.01	12.40	76	.03	.02	.02	60.	1.02	12.40	220	.41	.41	.00	1831.
1.01	12.50	77	.03	.02	.02	74.	1.02	12.50	221	.41	.41	.00	2157.
1.01	13.00	78	.03	.02	.01	86.	1.02	13.00	222	.41	.41	.00	2391.
1.01	13.10	79	.04	.02	.02	96.	1.02	13.10	223	.49	.49	.00	2554.
1.01	13.20	80	.04	.02	.02	106.	1.02	13.20	224	.49	.49	.00	2706.
1.01	13.30	81	.04	.02	.01	118.	1.02	13.30	225	.49	.49	.00	2870.
1.01	13.40	82	.04	.02	.01	129.	1.02	13.40	226	.49	.49	.00	3022.
1.01	13.50	83	.04	.02	.01	140.	1.02	13.50	227	.49	.49	.00	3145.
1.01	14.00	84	.04	.03	.01	149.	1.02	14.00	228	.49	.49	.00	3233.
1.01	14.10	85	.05	.03	.01	158.	1.02	14.10	229	.62	.61	.00	3313.
1.01	14.20	86	.05	.03	.01	169.	1.02	14.20	230	.62	.62	.00	3432.
1.01	14.30	87	.05	.03	.01	183.	1.02	14.30	231	.62	.62	.00	3605.
1.01	14.40	88	.05	.04	.01	197.	1.02	14.40	232	.62	.62	.00	3786.
1.01	14.50	89	.05	.04	.01	210.	1.02	14.50	233	.62	.62	.00	3939.
1.01	15.00	90	.05	.04	.01	221.	1.02	15.00	234	.62	.62	.00	4049.
1.01	15.10	91	.04	.03	.01	229.	1.02	15.10	235	.56	.56	.00	4106.
1.01	15.20	92	.07	.06	.02	238.	1.02	15.20	236	.94	.94	.00	4191.
1.01	15.30	93	.13	.11	.02	266.	1.02	15.30	237	1.69	1.69	.00	4559.
1.01	15.40	94	.32	.27	.05	360.	1.02	15.40	238	4.22	4.21	.01	5975.
1.01	15.50	95	.09	.08	.01	523.	1.02	15.50	239	1.22	1.22	.00	8411.
1.01	16.00	96	.06	.05	.01	682.	1.02	16.00	240	.75	.75	.00	10751.
1.01	16.10	97	.04	.04	.01	727.	1.02	16.10	241	.58	.58	.00	11312.
1.01	16.20	98	.04	.04	.00	673.	1.02	16.20	242	.58	.58	.00	10367.
1.01	16.30	99	.04	.04	.00	568.	1.02	16.30	243	.58	.58	.00	8666.
1.01	16.40	100	.04	.04	.00	466.	1.02	16.40	244	.58	.58	.00	7045.
1.01	16.50	101	.04	.04	.00	400.	1.02	16.50	245	.58	.58	.00	5999.
1.01	17.00	102	.04	.04	.00	357.	1.02	17.00	246	.58	.58	.00	5307.
1.01	17.10	103	.03	.03	.00	327.	1.02	17.10	247	.45	.45	.00	4820.
1.01	17.20	104	.03	.03	.00	303.	1.02	17.20	248	.45	.45	.00	4437.
1.01	17.30	105	.03	.03	.00	281.	1.02	17.30	249	.45	.45	.00	4091.
1.01	17.40	106	.03	.03	.00	262.	1.02	17.40	250	.45	.45	.00	3798.
1.01	17.50	107	.03	.03	.00	247.	1.02	17.50	251	.45	.45	.00	3570.
1.01	18.00	108	.03	.03	.00	238.	1.02	18.00	252	.45	.45	.00	3413.
1.01	18.10	109	.00	.00	.00	226.	1.02	18.10	253	.04	.04	.00	3231.
1.01	18.20	110	.00	.00	.00	202.	1.02	18.20	254	.04	.04	.00	2885.
1.01	18.30	111	.00	.00	.00	164.	1.02	18.30	255	.04	.04	.00	2334.
1.01	18.40	112	.00	.00	.00	122.	1.02	18.40	256	.04	.04	.00	1745.
1.01	18.50	113	.00	.00	.00	87.	1.02	18.50	257	.04	.04	.00	1245.
1.01	19.00	114	.00	.00	.00	63.	1.02	19.00	258	.04	.04	.00	891.
1.01	19.10	115	.00	.00	.00	47.	1.02	19.10	259	.04	.04	.00	671.
1.01	19.20	116	.00	.00	.00	37.	1.02	19.20	260	.04	.04	.00	526.
1.01	19.30	117	.00	.00	.00	30.	1.02	19.30	261	.04	.04	.00	429.
1.01	19.40	118	.00	.00	.00	26.	1.02	19.40	262	.04	.04	.00	366.
1.01	19.50	119	.00	.00	.00	23.	1.02	19.50	263	.04	.04	.00	325.
1.01	20.00	120	.00	.00	.00	21.	1.02	20.00	264	.04	.04	.00	298.
1.01	20.10	121	.00	.00	.00	20.	1.02	20.10	265	.04	.04	.00	280.
1.01	20.20	122	.00	.00	.00	19.	1.02	20.20	266	.04	.04	.00	269.

1.01	20.30	123	.00	.00	.00	18.	1.02	20.30	267	.04	.04	.00	262.
1.01	20.40	124	.00	.00	.00	18.	1.02	20.40	268	.04	.04	.00	256.
1.01	20.50	125	.00	.00	.00	18.	1.02	20.50	269	.04	.04	.00	253.
1.01	21.00	126	.00	.00	.00	18.	1.02	21.00	270	.04	.04	.00	251.
1.01	21.10	127	.00	.00	.00	18.	1.02	21.10	271	.04	.04	.00	250.
1.01	21.20	128	.00	.00	.00	18.	1.02	21.20	272	.04	.04	.00	250.
1.01	21.30	129	.00	.00	.00	18.	1.02	21.30	273	.04	.04	.00	250.
1.01	21.40	130	.00	.00	.00	18.	1.02	21.40	274	.04	.04	.00	250.
1.01	21.50	131	.00	.00	.00	18.	1.02	21.50	275	.04	.04	.00	250.
1.01	22.00	132	.00	.00	.00	18.	1.02	22.00	276	.04	.04	.00	250.
1.01	22.10	133	.00	.00	.00	18.	1.02	22.10	277	.04	.04	.00	250.
1.01	22.20	134	.00	.00	.00	18.	1.02	22.20	278	.04	.04	.00	250.
1.01	22.30	135	.00	.00	.00	18.	1.02	22.30	279	.04	.04	.00	250.
1.01	22.40	136	.00	.00	.00	18.	1.02	22.40	280	.04	.04	.00	250.
1.01	22.50	137	.00	.00	.00	18.	1.02	22.50	281	.04	.04	.00	250.
1.01	23.00	138	.00	.00	.00	18.	1.02	23.00	282	.04	.04	.00	250.
1.01	23.10	139	.00	.00	.00	18.	1.02	23.10	283	.04	.04	.00	250.
1.01	23.20	140	.00	.00	.00	18.	1.02	23.20	284	.04	.04	.00	250.
1.01	23.30	141	.00	.00	.00	18.	1.02	23.30	285	.04	.04	.00	250.
1.01	23.40	142	.00	.00	.00	18.	1.02	23.40	286	.04	.04	.00	250.
1.01	23.50	143	.00	.00	.00	18.	1.02	23.50	287	.04	.04	.00	250.
1.02	0.00	144	.00	.00	.00	18.	1.03	0.00	288	.04	.04	.00	250.
									SUM	33.88	32.86	1.02	225730.
										(861.1(	835.1(	26.1(| 6391.96)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11312.	4591.	1490.	783.	225601.
CMS	320.	130.	42.	22.	6388.
INCHES		23.95	31.09	32.69	32.69
MM		608.33	789.61	830.45	830.45
AC-FT		2276.	2955.	3107.	3107.
THOUS CU M		2808.	3645.	3833.	3833.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	566.	230.	74.	39.	11280.
CMS	16.	6.	2.	1.	319.
INCHES		1.20	1.55	1.63	1.63
MM		30.42	39.48	41.52	41.52
AC-FT		114.	148.	155.	155.
THOUS CU M		140.	182.	192.	192.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1131.	459.	149.	78.	22560.
CMS	32.	13.	4.	2.	639.
INCHES		2.39	3.11	3.27	3.27
MM		60.83	78.96	83.04	83.04
AC-FT		228.	295.	311.	311.
THOUS CU M		281.	364.	383.	383.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1697.	689.	223.	118.	33840.
CMS	48.	19.	6.	3.	958.
INCHES		3.59	4.66	4.90	4.90
MM		91.25	118.44	124.57	124.57
AC-FT		341.	443.	466.	466.
THOUS CU M		421.	547.	575.	575.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2262.	918.	298.	157.	45120.
CMS	64.	26.	8.	4.	1278.
INCHES		4.79	6.22	6.54	6.54
MM		121.67	157.92	166.09	166.09
AC-FT		455.	591.	621.	621.
THOUS CU M		562.	729.	767.	767.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3959.	1607.	521.	274.	78960.
CMS	112.	45.	15.	8.	2236.
INCHES		8.38	10.88	11.44	11.44
MM		212.91	276.37	290.66	290.66
AC-FT		797.	1034.	1088.	1088.
THOUS CU M		983.	1276.	1342.	1342.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6 [1/2 PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5656.	2295.	745.	392.	112800.
CMS	160.	65.	21.	11.	3194.
INCHES		11.97	15.54	16.35	16.35
MM		304.16	394.81	415.22	415.22
AC-FT		1138.	1477.	1554.	1554.
THOUS CU M		1404.	1822.	1916.	1916.

HYDROGRAPH AT STA0C0001 FOR PLAN 1, RTIO 7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8484.	3443.	1117.	588.	169201.
CMS	240.	97.	32.	17.	4791.
INCHES		17.96	23.32	24.52	24.52
MM		456.24	592.21	622.84	622.84
AC-FT		1707.	2216.	2331.	2331.
THOUS CU M		2106.	2733.	2875.	2875.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 8 [PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11312.	4591.	1490.	783.	225601.

CMS	320.	130.	42.	22.	6388.
INCHES		23.95	31.09	32.69	32.69
MM		608.33	789.61	830.45	830.45
AC-FT		2276.	2955.	3107.	3107.
THOUS CU M		2808.	3645.	3833.	3833.

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HYDROGRAPH ROUTING

ROUTED FLOWS THRU RESERVOIR 10261

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-110.	-1

STAGE	110.00	110.50	111.00	111.50	112.00	113.00	113.50	114.00	115.00	116.00
FLOW	0.00	100.00	250.00	500.00	800.00	1550.00	2050.00	2580.00	4010.00	5550.00
SURFACE AREA=	0.	3.	16.	39.	73.	98.	130.	171.		
CAPACITY=	0.	5.	91.	358.	909.	1335.	1903.	2653.		
ELEVATION=	75.	80.	90.	100.	110.	115.	120.	125.		

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
110.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
113.7	2.8	1.5	1200.

CREST LENGTH AT OR BELOW ELEVATION	0.	44.	200.	325.	675.	825.	1015.	1100.	1200.	1300.
	113.7	113.9	114.2	114.4	115.0	115.0	115.1	115.2	115.5	116.3

~~STATION 000002, PLAN 1, RATIO 1~~

~~END-OF-PERIOD HYDROGRAPH ORDINATES~~

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
1.	1.	2.	2.	2.	2.	3.	3.	3.	3.
4.	4.	4.	5.	5.	6.	7.	8.	9.	10.
10.	11.	11.	11.	11.	11.	11.	11.	11.	11.

OVN

STATION 000002, PLAN 1, RATIO 6 ½ PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
1.	1.	2.	2.	2.	2.	2.	3.	3.	3.
4.	4.	4.	5.	5.	6.	7.	8.	10.	11.
13.	14.	16.	18.	21.	23.	25.	28.	31.	33.
36.	39.	42.	47.	53.	62.	72.	82.	91.	97.
101.	106.	110.	112.	114.	115.	116.	116.	116.	116.
114.	112.	109.	105.	101.	98.	95.	92.	89.	86.
84.	81.	78.	76.	73.	71.	69.	67.	65.	63.
61.	59.	57.	55.	53.	52.	50.	49.	47.	46.
45.	43.	42.	41.	40.	39.	38.	38.	38.	39.
40.	41.	42.	43.	45.	46.	47.	48.	49.	50.
51.	52.	53.	54.	55.	56.	57.	57.	58.	59.
60.	60.	61.	62.	62.	63.	63.	64.	65.	65.
66.	67.	70.	76.	83.	92.	102.	117.	132.	146.
161.	174.	187.	200.	211.	223.	233.	244.	255.	270.
284.	296.	308.	318.	328.	337.	345.	352.	359.	365.
371.	376.	381.	386.	390.	394.	398.	408.	427.	460.
505.	567.	632.	698.	765.	840.	922.	1000.	1073.	1144.
1214.	1286.	1359.	1431.	1499.	1567.	1657.	1798.	2055.	2465.
3103.	3756.	4082.	4031.	3781.	3493.	3227.	2996.	2796.	2618.
2489.	2376.	2269.	2159.	2032.	1888.	1724.	1551.	1421.	1294.
1174.	1062.	959.	865.	784.	722.	666.	614.	567.	524.
487.	457.	430.	404.	381.	360.	340.	322.	305.	290.
276.	264.	252.	245.	238.	233.	227.	222.		

STORAGE

909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	910.
910.	910.	910.	910.	910.	910.	910.	910.	910.	910.
911.	911.	911.	911.	911.	911.	912.	912.	913.	913.
914.	915.	915.	916.	917.	918.	918.	919.	920.	921.
923.	924.	925.	926.	929.	932.	936.	940.	943.	945.
947.	948.	949.	949.	950.	950.	950.	950.	950.	950.
950.	949.	949.	948.	947.	945.	944.	943.	942.	941.
940.	939.	938.	937.	936.	935.	935.	934.	933.	932.
932.	931.	930.	930.	929.	928.	928.	927.	927.	926.
926.	925.	925.	924.	924.	923.	923.	923.	923.	924.
924.	924.	925.	925.	926.	926.	926.	927.	927.	928.
928.	928.	929.	929.	929.	930.	930.	930.	931.	931.
931.	931.	932.	932.	932.	932.	933.	933.	933.	933.
933.	934.	935.	937.	940.	943.	947.	951.	954.	958.
962.	965.	968.	972.	975.	978.	980.	983.	985.	988.
990.	992.	994.	995.	997.	998.	999.	1001.	1002.	1003.
1004.	1004.	1005.	1006.	1006.	1007.	1008.	1009.	1012.	1018.
1025.	1033.	1042.	1051.	1060.	1069.	1078.	1087.	1095.	1103.
1111.	1119.	1128.	1136.	1144.	1151.	1159.	1172.	1195.	1229.

1267.	1295.	1306.	1304.	1295.	1284.	1273.	1262.	1251.	1241.
1231.	1222.	1213.	1203.	1193.	1180.	1165.	1150.	1135.	1120.
1106.	1094.	1082.	1072.	1063.	1054.	1046.	1039.	1033.	1027.
1022.	1017.	1013.	1009.	1005.	1002.	999.	996.	993.	991.
989.	987.	985.	983.	982.	980.	979.	977.		

STAGE

110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.1
110.1	110.1	110.1	110.1	110.1	110.1	110.1	110.1	110.2	110.2
110.2	110.2	110.2	110.2	110.3	110.3	110.4	110.4	110.5	110.5
110.5	110.5	110.5	110.5	110.5	110.6	110.6	110.6	110.6	110.6
110.5	110.5	110.5	110.5	110.5	110.5	110.5	110.5	110.4	110.4
110.4	110.4	110.4	110.4	110.4	110.4	110.3	110.3	110.3	110.3
110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.2	110.2	110.2
110.2	110.2	110.2	110.2	110.2	110.2	110.2	110.2	110.2	110.2
110.2	110.2	110.2	110.2	110.2	110.2	110.2	110.2	110.2	110.3
110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3
110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3
110.3	110.3	110.4	110.4	110.4	110.5	110.5	110.6	110.6	110.7
110.7	110.7	110.8	110.8	110.9	110.9	110.9	111.0	111.0	111.0
111.1	111.1	111.1	111.1	111.2	111.2	111.2	111.2	111.2	111.2
111.2	111.3	111.3	111.3	111.3	111.3	111.3	111.3	111.4	111.4
111.5	111.6	111.7	111.8	111.9	112.1	112.2	112.3	112.4	112.5
112.6	112.6	112.7	112.8	112.9	113.0	113.1	113.2	113.5	113.9
114.3	114.6	114.7	114.7	114.6	114.5	114.4	114.2	114.1	114.0
113.9	113.8	113.7	113.6	113.5	113.3	113.2	113.0	112.8	112.7
112.5	112.3	112.2	112.1	112.0	111.9	111.8	111.7	111.6	111.5
111.5	111.4	111.4	111.3	111.3	111.2	111.2	111.1	111.1	111.1
111.1	111.0	111.0	111.0	111.0	110.9	110.9	110.9		

PEAK OUTFLOW IS 4082. AT TIME 40.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4082.	2106.	718.	374.	107853.
CMS	116.	60.	20.	11.	3054.
INCHES		10.99	14.98	15.63	15.63
MM		279.07	380.60	397.01	397.01
AC-FT		1044.	1424.	1486.	1486.
THOUS CU M		1288.	1757.	1832.	1832.

OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

	0.	1000.	2000.	3000.	4000.	5000.	6000.	0.	0.	0.	0.	0.	0.
.10	11												
.20	21												
.30	31												
.40	41												
.50	51												
1.00	61												
1.10	71												
1.20	81												
1.30	91												
1.40	101												
1.50	111												
2.00	121												
2.10	131												
2.20	141												
2.30	151												
2.40	161												
2.50	171												
3.00	181												
3.10	191												
3.20	201												
3.30	211												
3.40	221												
3.50	231												
4.00	241												
4.10	251												
4.20	261												
4.30	271												
4.40	281												
4.50	291												
5.00	301												
5.10	311												
5.20	321												
5.30	331												
5.40	341												
5.50	351												
6.00	361												
6.10	371												
6.20	381												
6.30	391												
6.40	401												
6.50	411												
7.00	421												
7.10	431												
7.20	441												
7.30	451												
7.40	461												
7.50	471												
8.00	481												
8.10	491												
8.20	501												
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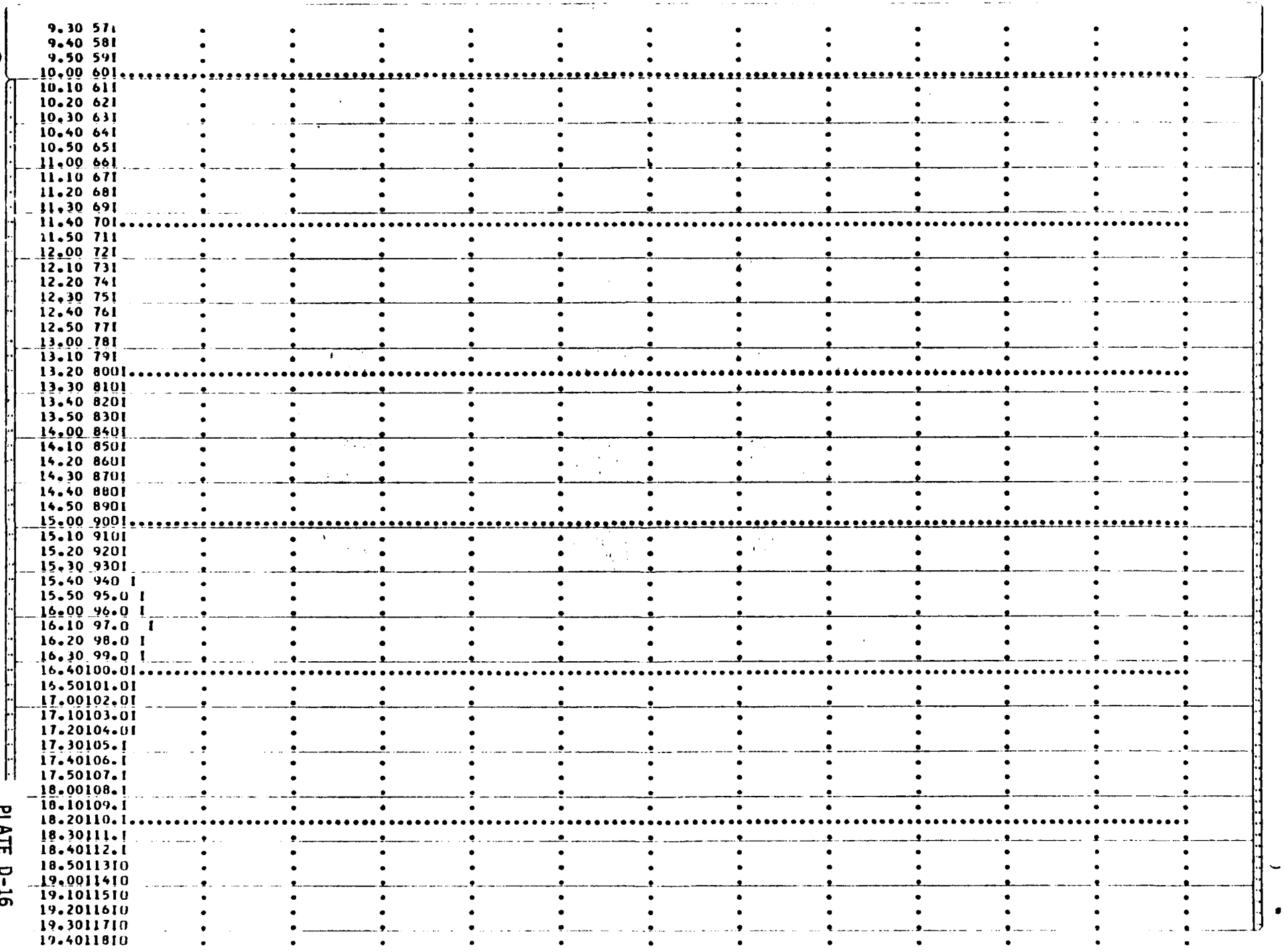
8.50	531												
9.00	541												
9.10	551												
9.20	561												

PLATE D-15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11.20 68
11.30 69
11.40 70
11.50 71
12.00 72
12.10 73
12.20 74
12.30 75
12.40 76
12.50 77
13.00 78
13.10 79
13.20 80
13.30 81
13.40 82
13.50 83
14.00 84
14.10 85
14.20 86
14.30 87
14.40 88
14.50 89
15.00 90
15.10 91
15.20 92
15.30 93
15.40 94
15.50 95.0
16.00 96.0
16.10 97.0
16.20 98.0
16.30 99.0
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16.50101.0
17.00102.0
17.10103.0
17.20104.0
17.30105.
17.40106.
17.50107.
18.00108.
18.10109.
18.20110.
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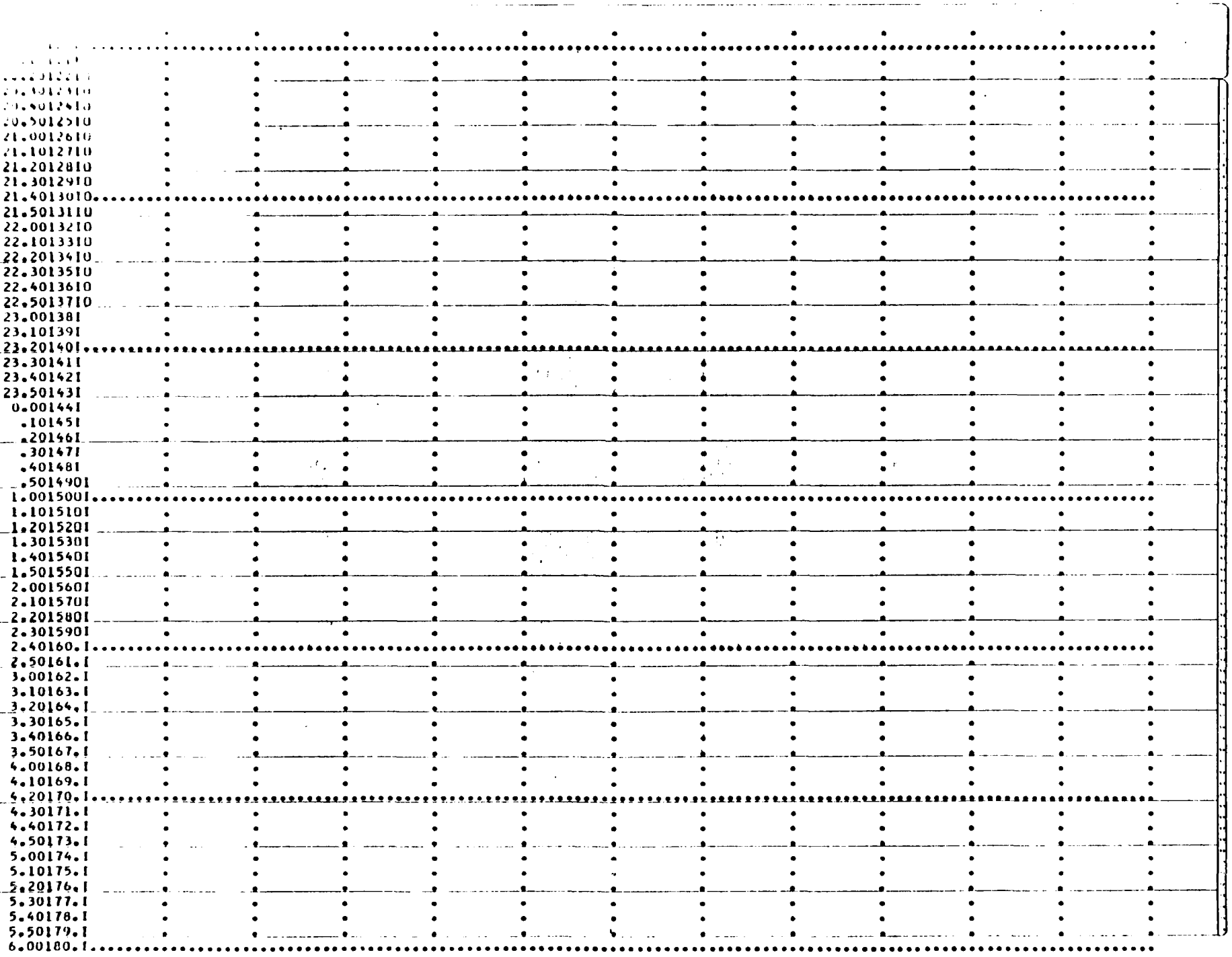
19.2011610
19.3011710
19.4011810

PLATE D-16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22.5013710
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PLATE D-17

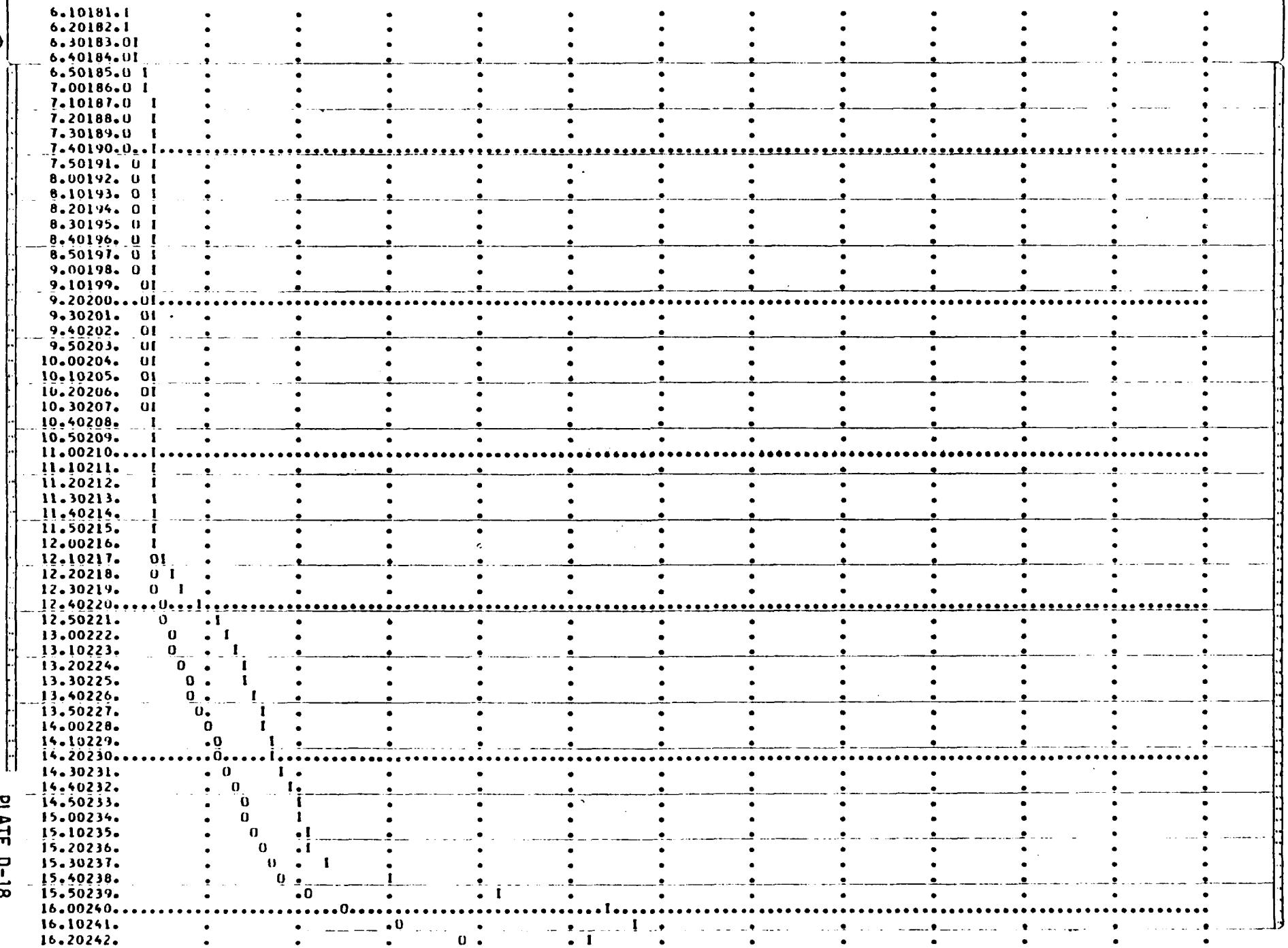
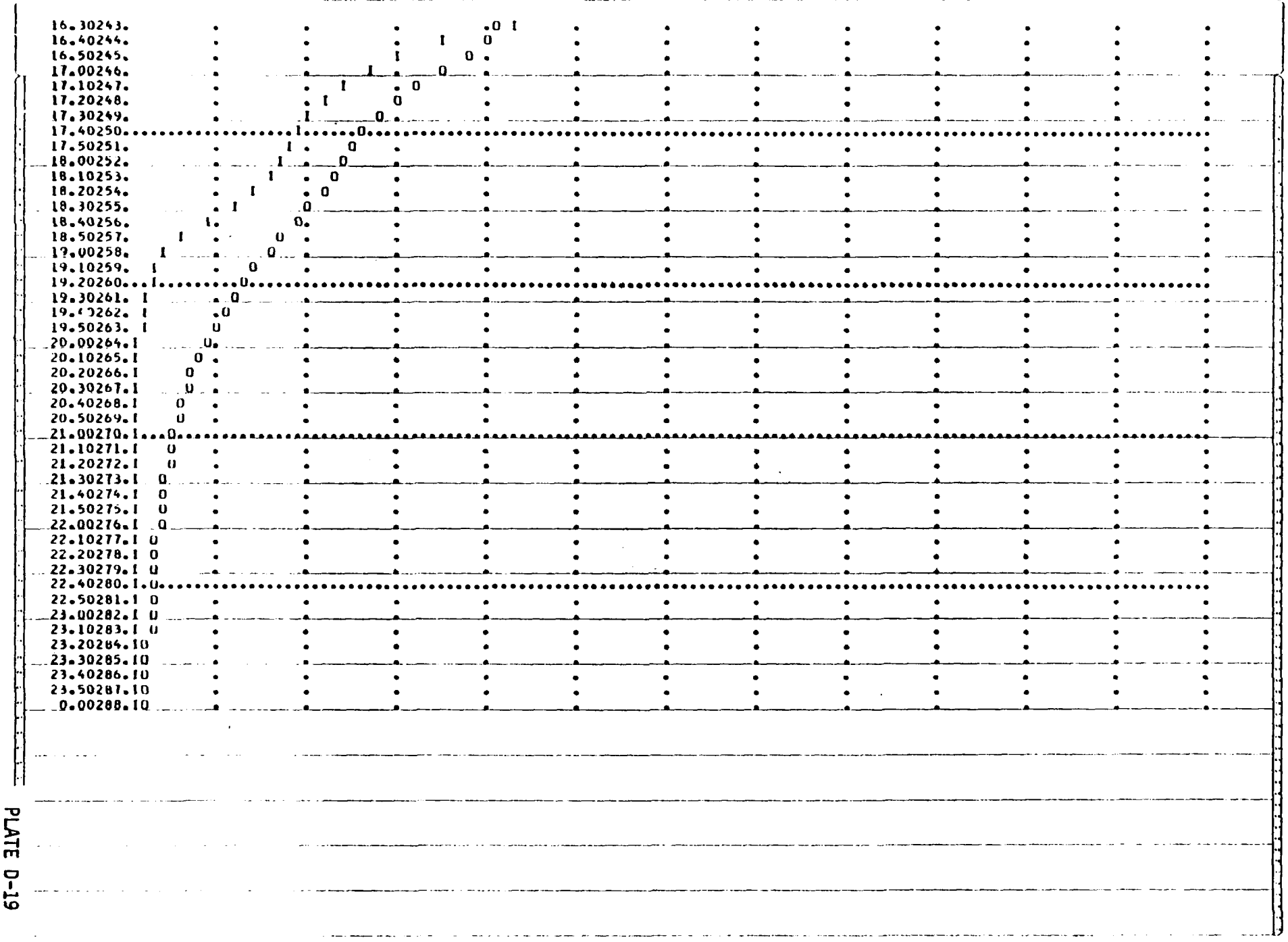


PLATE D-18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19.10259.
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19.30261.
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22.10277.
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22.30279.
22.40280.
22.50281.
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23.20284.10
23.30285.10
23.40286.10
23.50287.10
0.00288.10

PLATE D-19

OVN

STATION 000002, PLAN 1, RATIO 8 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	2.	2.
2.	3.	3.	4.	4.	4.	5.	6.	6.	7.
7.	8.	8.	9.	10.	12.	14.	16.	19.	22.
25.	29.	33.	37.	41.	46.	50.	55.	61.	66.
72.	78.	84.	92.	107.	134.	164.	192.	214.	230.
241.	248.	254.	259.	262.	263.	262.	261.	258.	254.
249.	243.	236.	228.	219.	210.	201.	192.	183.	174.
166.	159.	151.	144.	137.	131.	125.	119.	114.	109.
104.	100.	97.	94.	91.	88.	86.	83.	81.	79.
77.	75.	72.	70.	69.	67.	66.	67.	68.	70.
72.	74.	77.	79.	82.	84.	87.	89.	92.	94.
96.	98.	101.	104.	106.	109.	112.	114.	116.	118.
121.	123.	124.	126.	128.	129.	131.	132.	134.	135.
137.	141.	150.	164.	185.	209.	236.	272.	316.	358.
397.	434.	468.	500.	534.	565.	594.	620.	643.	664.
683.	701.	716.	731.	744.	755.	766.	776.	784.	792.
800.	808.	815.	821.	827.	832.	840.	862.	911.	996.
1112.	1245.	1384.	1524.	1699.	1879.	2051.	2221.	2377.	2530.
2720.	2940.	3168.	3390.	3588.	3759.	3957.	4409.	5554.	7769.
9833.	10503.	9846.	8565.	7324.	6381.	5695.	5196.	4814.	4484.
4198.	3959.	3755.	3544.	3281.	2966.	2637.	2382.	2143.	1919.
1712.	1528.	1395.	1272.	1160.	1058.	966.	884.	810.	755.
707.	663.	623.	587.	554.	524.	498.	478.	459.	442.
426.	411.	398.	385.	374.	364.	354.	346.		

STORAGE

909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	909.	909.	909.	909.
909.	909.	909.	909.	909.	909.	910.	910.	910.	910.
910.	910.	910.	911.	911.	911.	911.	911.	911.	912.
912.	912.	912.	913.	913.	914.	914.	915.	916.	917.
918.	920.	921.	923.	924.	926.	928.	930.	932.	934.
936.	938.	940.	943.	948.	955.	962.	970.	975.	979.
982.	984.	985.	986.	986.	987.	986.	986.	986.	985.
984.	983.	981.	979.	977.	974.	972.	970.	967.	965.
963.	961.	959.	957.	956.	954.	953.	951.	950.	949.
947.	946.	945.	944.	943.	942.	941.	940.	939.	938.
938.	937.	936.	935.	935.	934.	934.	934.	934.	935.
936.	937.	938.	938.	939.	940.	941.	942.	943.	944.
945.	946.	946.	947.	948.	949.	949.	950.	950.	951.
951.	952.	952.	953.	953.	954.	954.	954.	955.	955.
956.	957.	959.	963.	968.	974.	981.	988.	995.	1001.
1008.	1013.	1019.	1024.	1029.	1033.	1037.	1040.	1043.	1046.
1049.	1051.	1053.	1055.	1057.	1059.	1060.	1061.	1063.	1064.
1065.	1066.	1066.	1067.	1068.	1068.	1069.	1071.	1077.	1086.
1099.	1115.	1130.	1147.	1163.	1179.	1194.	1209.	1222.	1235.
1247.	1259.	1270.	1280.	1288.	1295.	1302.	1317.	1347.	1387.

1418.	1427.	1418.	1400.	1380.	1364.	1350.	1339.	1329.	1319.
1310.	1302.	1294.	1286.	1275.	1260.	1242.	1223.	1202.	1182.
1164.	1147.	1132.	1118.	1105.	1093.	1083.	1074.	1066.	1059.
1052.	1046.	1041.	1036.	1031.	1027.	1024.	1020.	1017.	1015.
1012.	1010.	1008.	1006.	1004.	1002.	1001.	1000.		

STAGE

110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
110.0	110.0	110.0	110.0	110.1	110.1	110.1	110.1	110.1	110.1
110.1	110.1	110.2	110.2	110.2	110.2	110.3	110.3	110.3	110.3
110.4	110.4	110.4	110.5	110.5	110.6	110.7	110.8	110.9	110.9
111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0
111.0	111.0	111.0	110.9	110.9	110.9	110.8	110.8	110.8	110.7
110.7	110.7	110.7	110.6	110.6	110.6	110.6	110.6	110.5	110.5
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110.4	110.4	110.4	110.4	110.3	110.3	110.3	110.3	110.3	110.3
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110.6	110.6	110.7	110.7	110.8	110.9	111.0	111.0	111.1	111.2
111.3	111.4	111.4	111.5	111.6	111.6	111.7	111.7	111.7	111.8
111.8	111.8	111.9	111.9	111.9	111.9	111.9	112.0	112.0	112.0
112.0	112.0	112.0	112.0	112.0	112.0	112.1	112.1	112.1	112.3
112.4	112.6	112.8	113.0	113.1	113.3	113.5	113.7	113.8	113.9
114.1	114.2	114.3	114.4	114.5	114.6	114.7	114.8	115.1	115.5
115.8	115.9	115.8	115.6	115.5	115.3	115.2	115.0	114.9	114.8
114.7	114.7	114.6	114.5	114.4	114.2	114.0	113.8	113.6	113.4
113.2	113.0	112.8	112.6	112.5	112.3	112.2	112.1	112.0	111.9
111.8	111.8	111.7	111.6	111.6	111.5	111.5	111.5	111.4	111.4
111.4	111.3	111.3	111.3	111.2	111.2	111.2	111.2		

PEAK OUTFLOW IS 10503. AT TIME 40.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10503.	4373.	1457.	761.	219038.
CMS	297.	124.	41.	22.	6202.
INCHES		22.82	30.41	31.74	31.74
MM		579.55	772.42	806.29	806.29
AC-FT		2169.	2890.	3017.	3017.
THOUS CU M		2675.	3565.	3721.	3721.

OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

0. 2000. 4000. 6000. 8000. 10000. 12000. 0. 0. 0. 0. 0. 0.

.10 11
.20 21
.30 31
.40 41
.50 51
1.00 61
1.10 71
1.20 81
1.30 91
1.40 101
1.50 111
2.00 121
2.10 131
2.20 141
2.30 151
2.40 161
2.50 171
3.00 181
3.10 191
3.20 201
3.30 211
3.40 221
3.50 231
4.00 241
4.10 251
4.20 261
4.30 271
4.40 281
4.50 291
5.00 301
5.10 311
5.20 321
5.30 331
5.40 341
5.50 351
6.00 361
6.10 371
6.20 381
6.30 391
6.40 401
6.50 411
7.00 421
7.10 431
7.20 441
7.30 451
7.40 461
7.50 471
8.00 481
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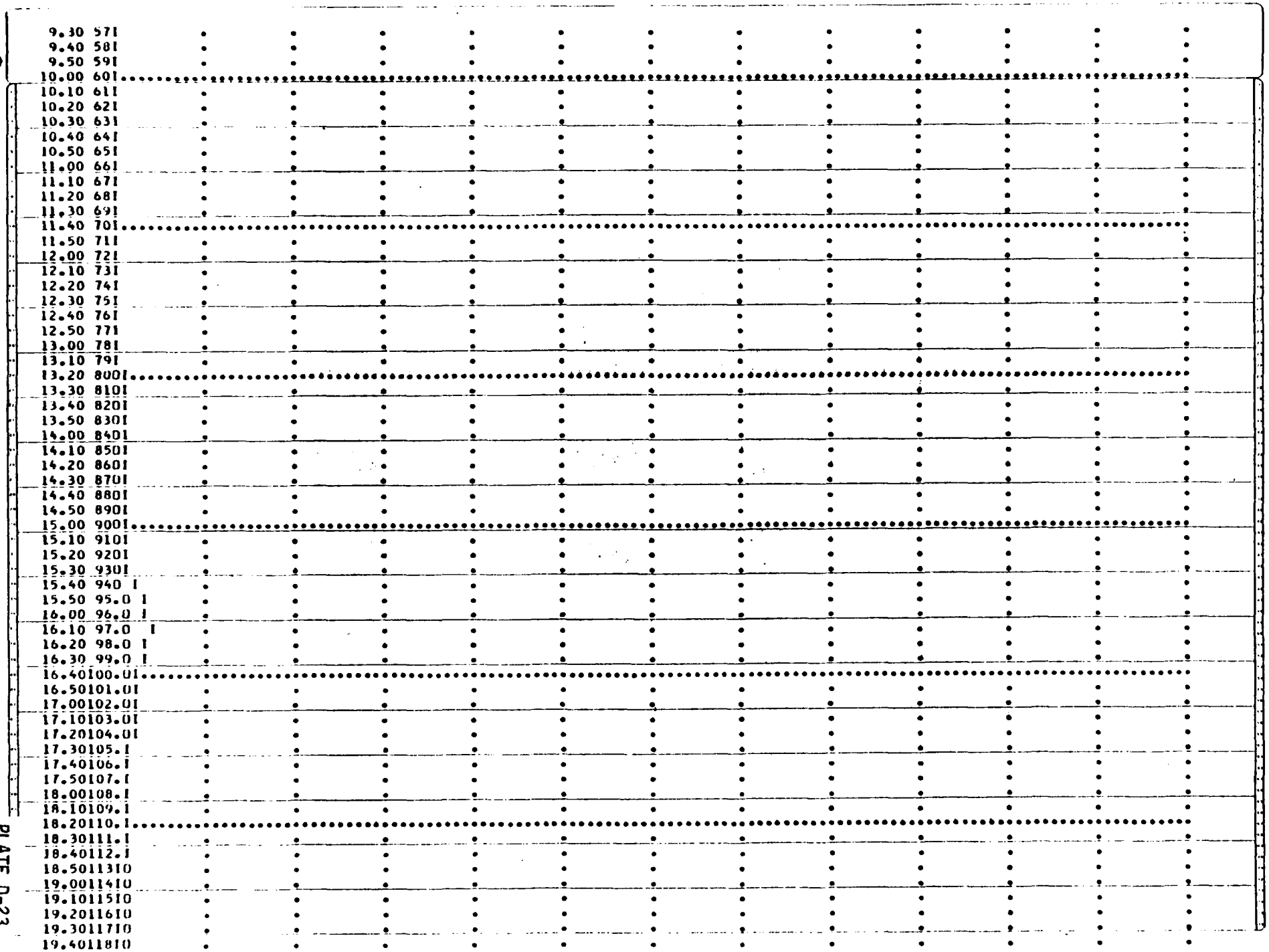
8.50 531
9.00 541
9.10 551
9.20 561

PLATE D-22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11.10 67I
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12.00 72I
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12.20 74I
12.30 75I
12.40 76I
12.50 77I
13.00 78I
13.10 79I
13.20 80I
13.30 81OI
13.40 82OI
13.50 83OI
14.00 84OI
14.10 85OI
14.20 86OI
14.30 87OI
14.40 88OI
14.50 89OI
15.00 90OI
15.10 91OI
15.20 92OI
15.30 93OI
15.40 940 I
15.50 95.0 I
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16.10 97.0 I
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17.40106.I
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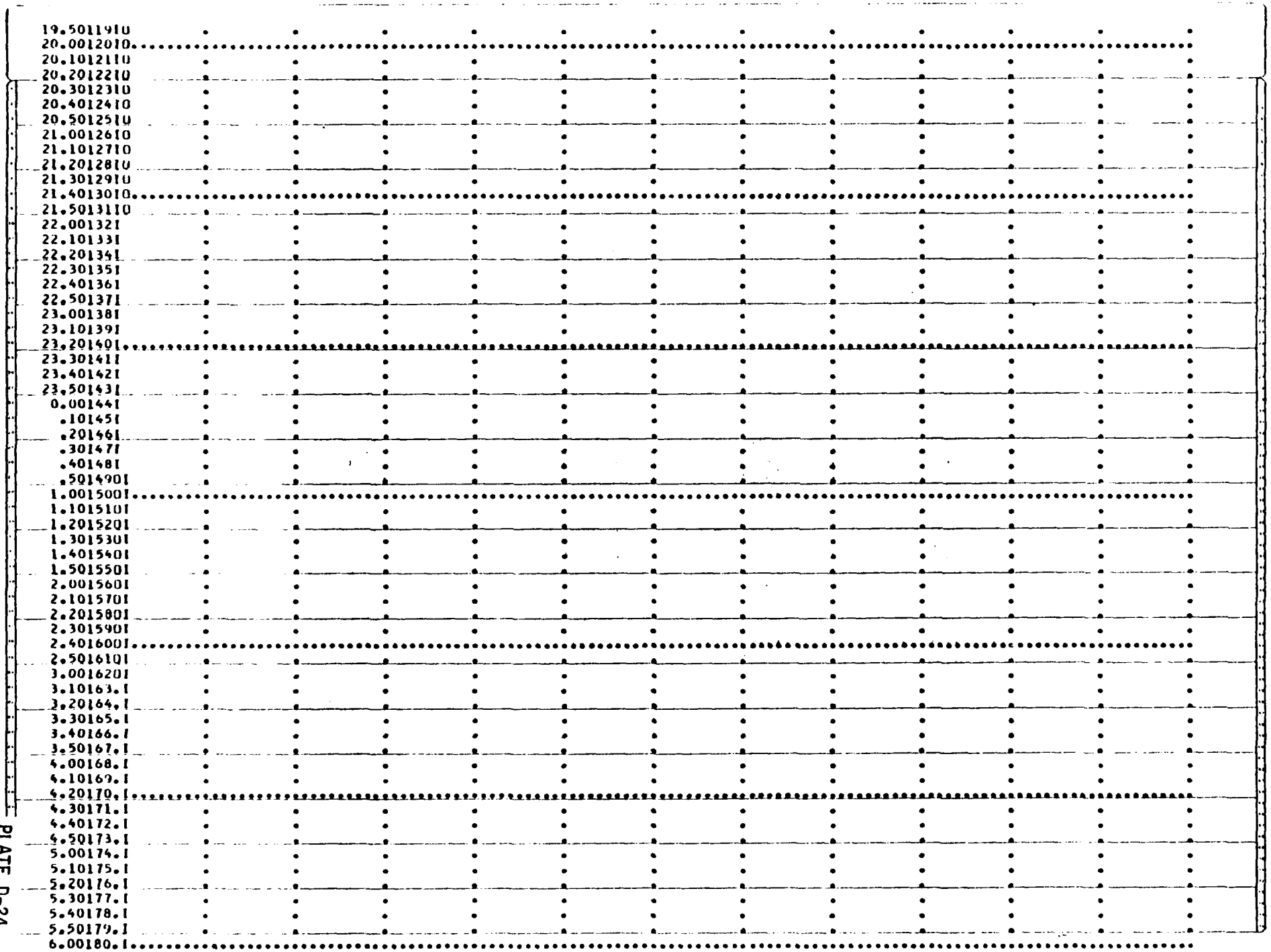
19.4011810

PLATE D-23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21.3012910
21.4013010
21.5013110
22.001321
22.101331
22.201341
22.301351
22.401361
22.501371
23.001381
23.101391
23.201401
23.301411
23.401421
23.501431
0.001441
.101451
.201461
.301471
.401481
.501491
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1.101511
1.201521
1.301531
1.401541
1.501551
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2.301591
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2.501611
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4.50173.1
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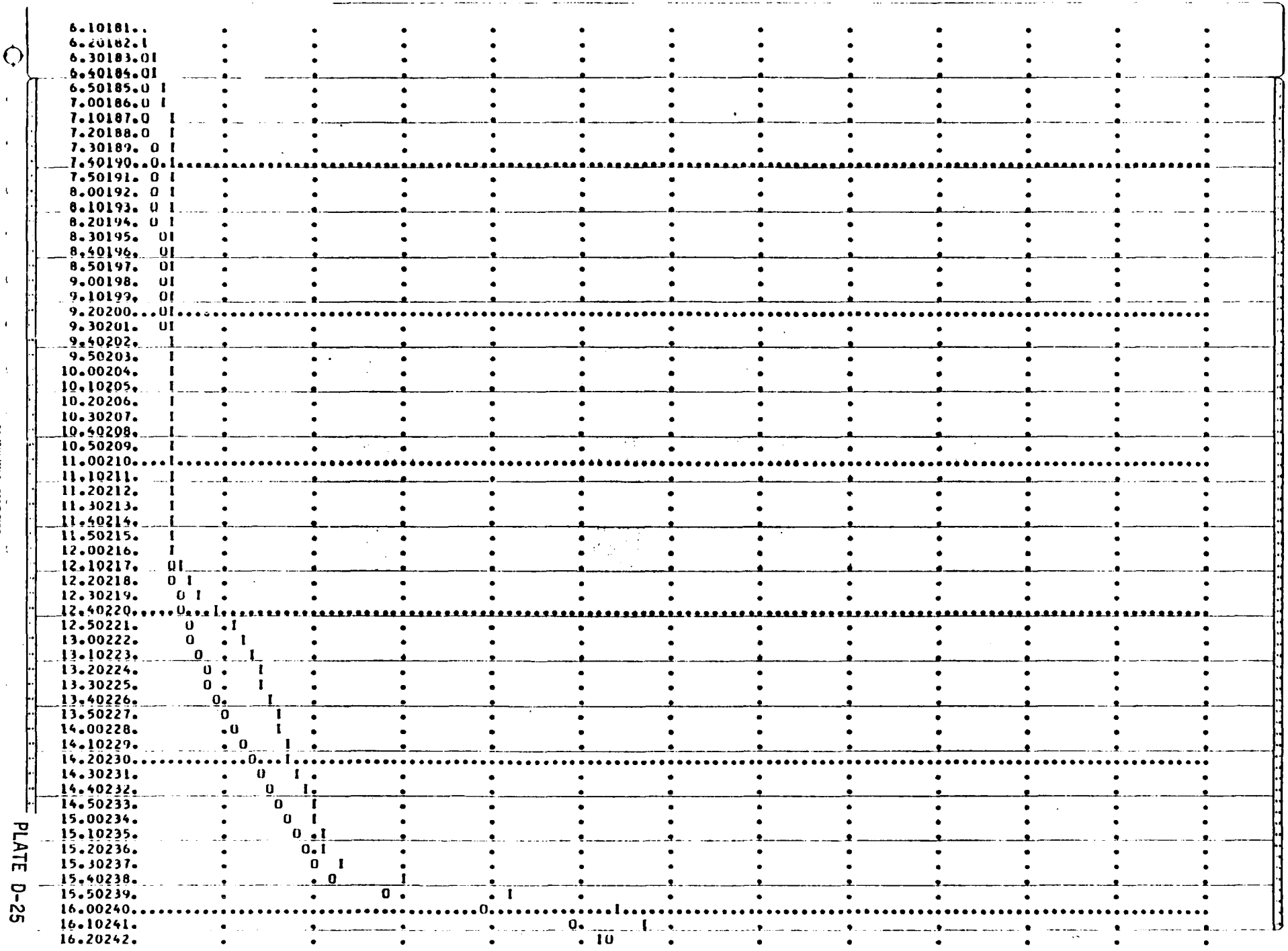
5.40178.1
5.50179.1
6.00180.1

PLATE D-24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8.10193. 0 I
8.20194. 0 I
8.30195. 0I
8.40196. 0I
8.50197. 0I
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9.10199. 0I
9.20200...0I
9.30201. 0I
9.40202. I
9.50203. I
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10.10205. I
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11.20212. I
11.30213. I
11.40214. I
11.50215. I
12.00216. I
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12.30219. 0 I
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14.10229. . 0 I
14.20230.....0...I
14.30231. . 0 I
14.40232. . 0 I.
14.50233. . 0 I
15.00234. . 0 I
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15.20236. . 0.I
15.30237. . 0 I
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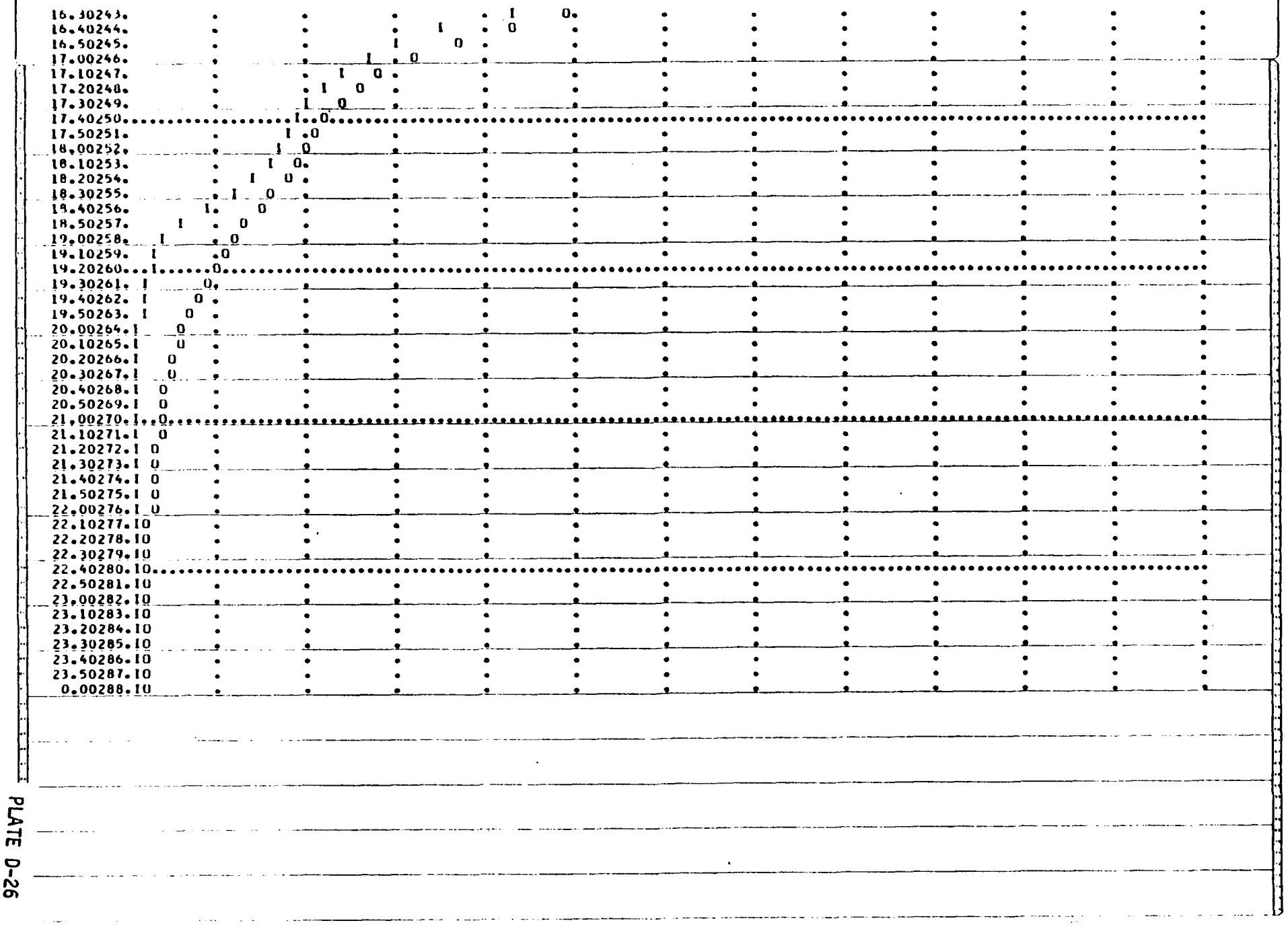
PLATE D-25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19.00258.
19.10259.
19.20260.
19.30261.
19.40262.
19.50263.
20.00264.
20.10265.
20.20266.
20.30267.
20.40268.
20.50269.
21.00270.
21.10271.
21.20272.
21.30273.
21.40274.
21.50275.
22.00276.
22.10277.
22.20278.
22.30279.
22.40280.
22.50281.
23.00282.
23.10283.
23.20284.
23.30285.
23.40286.
23.50287.
0.00288.

PLATE D-26

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1 .05	RATIO 2 .10	RATIO 3 .15	RATIO 4 .20	RATIO 5 .35	RATIO 6 .50	RATIO 7 .75	RATIO 8 1.00
HYDROGRAPH AT	000001	1.78	1	566.	1131.	1697.	2262.	3959.	5656.	8484.	11312.
		(4.62)		(16.02)(	32.03)(	48.05)(	64.07)(	112.12)(	160.17)(	240.25)(	320.33)(
ROUTED TO	000002	1.78	1	219.	543.	895.	1258.	2418.	4082.	7418.	10503.
		(4.62)		(6.20)(	15.36)(	25.36)(	35.61)(	68.46)(	115.58)(	210.07)(	297.42)(

PLATE D-27

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	110.00	110.00	113.70
STORAGE	909.	909.	1212.
OUTFLOW	0.	0.	2262.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	110.90	0.00	977.	219.	0.00	41.33	0.00
.10	111.57	0.00	1030.	543.	0.00	41.00	0.00
.15	112.13	0.00	1075.	895.	0.00	40.83	0.00
.20	112.61	0.00	1116.	1258.	0.00	40.83	0.00
.35	113.84	.14	1226.	2418.	.67	40.67	0.00
.50	114.70	1.00	1306.	4082.	2.33	40.50	0.00
.75	115.47	1.77	1382.	7418.	3.83	40.33	0.00
1.00	115.91	2.21	1427.	10503.	5.00	40.33	0.00

PLATE D-28